

# The luaotfload package

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## Abstract

This package is an adaptation of the Con $\TeX$ t 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  $\XeTeX$ ,  $\text{Lua}\TeX$  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:

```
\font\foo={\langle prefix\rangle:\langle font name\rangle:\langle font features\rangle} \langle \TeX font features\rangle
```

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

**Prefix** The  $\langle prefix \rangle$  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  $\langle font name \rangle$  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  $\langle font name \rangle$  can be either a font filename or actual font name based on the  $\langle prefix \rangle$  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,

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

---

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

**Font features** *<font features>* 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 and node. base mode works by mapping OpenType features to traditional T<sub>E</sub>X ligature and kerning mechanisms, thus supporting only non-contextual substitutions and kerning pairs, but is slightly faster. node works by direct processing of the node list at Lua end and have more wide support of OpenType features but can be slow especially with complex fonts and can't be used in math mode.

By default node mode is used, and you have to manually force base mode when needed e.g. for math fonts.

**script**

OpenType script string, default value is dflt. Some fonts don't assign features to the dflt script, in which case the script need 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 syntax is documented in Adobe's [OpenType Feature File Specification](#).

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
```

---

<sup>2</sup>You also need to set \pdfprotrudechars2 \pdfadjustspacing2 to activate protrusion and expansion, respectively. See PDF<sub>T</sub><sub>E</sub>X manual for details

**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`.
- `itlc`: compute italic correction values (on by default).
- `tlig`: applies legacy T<sub>E</sub>X ligatures (``'-- -- !` ?` <>>`).
- `trep`: applies legacy T<sub>E</sub>X replacements (``'"`).

(For X<sub>Y</sub>T<sub>E</sub>X users: these last two are the equivalent of writing `mapping=text-tex` using X<sub>Y</sub>T<sub>E</sub>X'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 LuaT<sub>E</sub>X. 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 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 LuaT<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

---

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

`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 blacklisted 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 ConT<sub>E</sub>Xt files

This package is a wrapper for several files taken from the ConT<sub>E</sub>Xt macro package. The philosophy is to let ConT<sub>E</sub>Xt do all the implementation and update these files from time to time. So we try not to modify the files taken from ConT<sub>E</sub>Xt as far as possible, but we changed their names to prevent name clashes.

The ConT<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-ctx.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:

- |                             |                             |                             |
|-----------------------------|-----------------------------|-----------------------------|
| • <code>font-clr.lua</code> | • <code>font-nms.lua</code> | • <code>luat-ovr.lua</code> |
|-----------------------------|-----------------------------|-----------------------------|

## 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 `dflt` 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;
```

### File I

## `luaotfload.lua`

First some usual initializations.

```

1 module("luaotfload", package.seeall)
2
3 luaotfload.module = {
4     name      = "luaotfload",
5     version    = 1.28,
6     date      = "2013/04/11",
7     description = "OpenType layout system.",
8     author     = "Elie Roux & Hans Hagen",
9     copyright  = "Elie Roux",
10    license    = "CC0"
11 }
12
13 local error, warning, info, log = luatexbase.provides_module(luaotfload.module)

```

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.

```

14 kpse.init_prog("", 600, "/")

```

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

```

15 local luatex_version = 60
16
17 if tex.luatexversion < luatex_version then
18     warning("LuaTeX v%.2f is old, v%.2f is recommended.",
19             tex.luatexversion/100,
20             luatex_version /100)
21 end

```

## 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.

```

22 function luaotfload.loadmodule(name)
23     local tofind = "otfl-".name
24     local found = kpse.find_file(tofind,"tex")
25     if found then
26         log("loading file %s.", found)
27         dofile(found)
28     else
29         error("file %s not found.", tofind)
30     end
31 end

```

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.

```

32 luaotfload.loadmodule("luat-dum.lua") -- not used in context at all
33 luaotfload.loadmodule("luat-ovr.lua") -- override some luat-dum functions
34 luaotfload.loadmodule("data-con.lua") -- maybe some day we don't need this one

```

A hack to remove a warning from `node-dum.lua` as it is ConTeXt specific.

```
35 tex.attribute[0] = 0
```

Node support modules.

```
36 luaotfload.loadmodule("font-ini.lua")
37 luaotfload.loadmodule("node-dum.lua")
38 luaotfload.loadmodule("node-inj.lua")
```

By default ConTeXt 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.

```
39 function attributes.private(name)
40   local attr = "otfl@" .. name
41   local number = luatexbase.attributes[attr]
42   if not number then
43     number = luatexbase.new_attribute(attr)
44   end
45   return number
46 end
```

Font handling modules.

```
47 luaotfload.loadmodule("font-tfm.lua")
48 luaotfload.loadmodule("font-cid.lua")
49 luaotfload.loadmodule("font-ott.lua")
50 luaotfload.loadmodule("font-map.lua")
51 luaotfload.loadmodule("font-otf.lua")
52 luaotfload.loadmodule("font-otd.lua")
53 luaotfload.loadmodule("font-oti.lua")
54 luaotfload.loadmodule("font-otb.lua")
55 luaotfload.loadmodule("font-otn.lua")
56 luaotfload.loadmodule("font-ota.lua")
57 luaotfload.loadmodule("font-otc.lua")
58 luaotfload.loadmodule("font-def.lua")
59 luaotfload.loadmodule("font-xtx.lua")
60 luaotfload.loadmodule("font-dum.lua")
```

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`.

```
61 if fonts and fonts.tfm and fonts.tfm.readers then
62   fonts.tfm.readers.ofm = fonts.tfm.readers.tfm
63 end
```

luaotfload specific modules.

```
64 luaotfload.loadmodule("font-nms.lua")
65 luaotfload.loadmodule("font-clr.lua")
```

## 5.2 Post-processing TFM table

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

First we create a callback for patching fonts on the fly, to be used by other packages.

```
66 luatexbase.create_callback("luaotfload.patch_font", "simple", function() end)
    then define a function where font manipulation will take place.
```

```
67 local function def_font(...)
68     local fontdata = fonts.define.read(...)
69     if type(fontdata) == "table" and fontdata.shared then
```

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

```
70         local otfddata = fontdata.shared.otfddata
71         if otfddata.metadata.math then
72             local mc = { }
73             for k,v in next, otfddata.metadata.math do
74                 if k:find("Percent") then
75                     -- keep percent values as is
76                     mc[k] = v
77                 else
78                     mc[k] = v / fontdata.units * fontdata.size
79                 end
80             end
81             -- for \overwithdelims
82             mc.FractionDelimiterSize = 1.01 * fontdata.size
83             mc.FractionDelimiterDisplayStyleSize = 2.39 * fontdata.size
84
85             fontdata.MathConstants = mc
86         end
```

Execute any registered font patching callbacks.

```
87         luatexbase.call_callback("luaotfload.patch_font", fontdata)
88     end
89     return fontdata
90 end
```

## 5.3 Con $\TeX$ t override

We have a unified function for both file and name resolver.

```
91 fonts.define.resolvers.file = fonts.define.resolvers.name
```

Overriding some defaults set in Con $\TeX$ t code.

```
92 fonts.mode = "node"
```

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

```
93 local register_base_sub = fonts.otf.features.register_base_substitution
94 local gsubs = {
95     "ss01", "ss02", "ss03", "ss04", "ss05",
```



```

96     "ss06", "ss07", "ss08", "ss09", "ss10",
97     "ss11", "ss12", "ss13", "ss14", "ss15",
98     "ss16", "ss17", "ss18", "ss19", "ss20",
99 }
100
101 for _,v in next, gsubs do
102     register_base_sub(v)
103 end

```

Finally we register the callbacks

```

104 luatexbase.add_to_callback("pre_linebreak_filter",
105                             nodes.simple_font_handler,
106                             "luaotfload.pre_linebreak_filter")
107 luatexbase.add_to_callback("hpack_filter",
108                             nodes.simple_font_handler,
109                             "luaotfload.hpack_filter")
110 luatexbase.reset_callback("define_font")
111 luatexbase.add_to_callback("define_font",
112                             def_font,
113                             "luaotfload.define_font", 1)
114 luatexbase.add_to_callback("find_vf_file",
115                             fonts.vf.find,
116                             "luaotfload.find_vf_file")

```

XXX: see <https://github.com/wspr/unicode-math/issues/185>

Lua $\TeX$  does not provide interface to accessing (Script)ScriptPercentScaleDown math constants, so we emulate X $\TeX$  behaviour by setting `\fontdimen10` and `\fontdimen11`.

```

117 local function set_sscales_diments(fontdata)
118     local mc = fontdata.MathConstants
119     if mc then
120         if mc["ScriptPercentScaleDown"] then
121             fontdata.parameters[10] = mc.ScriptPercentScaleDown
122         else -- resort to plain TeX default
123             fontdata.parameters[10] = 70
124         end
125         if mc["ScriptScriptPercentScaleDown"] then
126             fontdata.parameters[11] = mc.ScriptScriptPercentScaleDown
127         else -- resort to plain TeX default
128             fontdata.parameters[11] = 50
129         end
130     end
131 end
132
133 luatexbase.add_to_callback("luaotfload.patch_font", set_sscales_diments, "unicodemath.set_sscales")

```

## File II

# luaotfload.sty

Classical Plain+ $\LaTeX$  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 luatexbase.sty
7 \else
8   \NeedsTeXFormat{LaTeX2e}
9   \ProvidesPackage{luaotfload}%
10    [2012/05/28 v1.27 OpenType layout system]
11   \RequirePackage{luatexbase}
12 \fi
13
14 \RequireLuaModule{lualibs}
15
16 Finally we load the lua module.
17 \RequireLuaModule{luaotfload}
```

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

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