Using OpenType and TrueType fonts with X\LaTeX and Lua\LaTeX

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Abstract

For both “new” \TeX engines \XeLaTeX and \LuaLaTeX, which are admittedly no longer all that new, there are a few things to consider in connection with fonts that are important for users who have previously worked with pdf\LaTeX. Until now, only the fonts that came with the \TeX distribution in use were easily available to “inexperienced” users.

1 Introduction

With the use of X\LaTeX or Lua\LaTeX the following facts have to be considered:

- The default font is by definition Latin Modern, regardless of whether \texttt{fontspec} is loaded or not. For pdf\LaTeX, the default is Computer Modern.
- The packages \texttt{inputenc} and/or \texttt{fontenc} should not be loaded. First, UTF-8 is already for years the all-but-universal default input encoding, and second, \texttt{fontspec} automatically loads \texttt{fontenc} with the \TeX (Unicode) encoding.
- To support OpenType fonts for math, load the \texttt{unicode-math} package instead of the \texttt{amsfonts} and/or \texttt{amssymb} packages. The \texttt{amsmath} package can still be used, but should be loaded \texttt{before} \texttt{fontspec}/\texttt{unicode-math}.
- The \texttt{xltextra} and \texttt{xunicode} packages are obsolete and should no longer be used.

The \texttt{fontspec} package can be used with both \XeLaTeX and Lua\LaTeX:

\texttt{\usepackage[\langle options\rangle]{fontspec}}

It greatly simplifies the integration of OpenType and TrueType fonts that are not part of the \TeX distribution. In order for the system to find them automatically, they must either be in the current document directory or, depending on the operating system, in (usually) one of the following directories:

\begin{itemize}
  \item GNU/Linux: \texttt{/usr/share/fonts}
  \texttt{/usr/local/share/fonts}
  \texttt{~/.fonts} (user-specific)
  \item Windows: \texttt{C:\Windows\Fonts}
  \item macOS: \texttt{/System/Library/Fonts}
  \texttt{/Library/Fonts}
  \texttt{~/.Library/Fonts} (user-specific)
\end{itemize}

Any other readable directory can be used, if the path is passed to the package \texttt{fontspec}.

The properties of a font can be displayed with an appropriate program, e.g. \texttt{otfinfo}, which is available on every \TeX distribution. For a font which is part of the \TeX directory tree, one can simplify the argument: the complete path is not needed, since it can be found with \texttt{kpsewhich}:

\begin{verbatim}
$ kpsewhich ComicNeue-Regular.otf
Family: Comic Neue
Subfamily: Regular
Full name: Comic Neon Regular
PostScript name: ComicNeue-Regular
Version: 2.003;hotconv 1.0.109
Unique ID: 2.003;;Comic Neon Light
Designer: Craig Rozynski
Designer URL: http://www.craigrozynski.com
Manufacturer: Craig Rozynski
Vendor URL: http://www.comicneue.com
Copyright: Copyright 2014 The Comic Neue
Project Authors (https://github.com/crozynski/comicneue)
License URL: https://scripts.sil.org/OFL
License Description: This Font Software is licensed under the SIL Open Font License, Version 1.1. [...]
Vendor ID: UKWN
\end{verbatim}

2 Font search: luaotfload-tool and luafindfont

The program \texttt{luaotfload-tool} can be used to list the fonts installed on the system. Both system fonts and \TeX distribution fonts are taken into account. However, the program is geared more to the needs of \TeX itself than to those of users. For example, searching for the font “Times” typically returns something like this:

\begin{verbatim}
$ luaotfload-tool --find=times
luaotfload | resolve : Font "times" found!
luaotfload | resolve : Resolved file name "/System/Library/Fonts/Times.ttc", subfont nr. 0
\end{verbatim}

That is, the output of the script is only one font, although several variants are installed, albeit with different file names. The search can be expanded by using the \texttt{--fuzzy} option. Now searching for “times new roman”, for example:

\begin{verbatim}
$ luaotfload-tool --find=times --fuzzy
luaotfload | resolve : Font "times new roman" found!
luaotfload | resolve : Resolved file name "/System/Library/Fonts/Supplemental/Times New Roman.ttf", subfont nr. 0
\end{verbatim}

But even this search is not especially successful. With the Lua utility \texttt{luafindfont}, which is part of the \TeX distribution, searching for \texttt{times} yields more informative results (see Listing 1).

The \texttt{luafindfont} program can be started with various options and also allows an AND condition when specifying the font to search for. A brief listing of the options:

\begin{verbatim}
-h,--help
-i,--info font number to use (default 0)
\end{verbatim}
A short test with the font Cambria and now a change to the font Dejavu and now at last to the font Arial.

The main (string) argument is usually (part of) a font name, but can contain extra conditions, as explained below. A longer description of the options:

- `-i (number)` The existing font styles are output for the font with the specified number.
- `-m (number)` Number of characters to be used for the output of the font name including the path. The full path specification can be very long and thus can be limited, for example, to 50 characters by specifying `-m 50`. Characters in the middle of the path are replaced with “...”.
- `-n` Omit the symbolic (family) names column from the output.
- `-o (number) [option]` The otfinfo program is run on the font with the specified number to supply additional font information. Options for `otfinfo` must immediately follow the font number.
- `-x` Test if font is found by `kpsewhich` (1/0).

Some example applications of `luafindfont`:

```tex
\usepackage{fontspec}
\fontspec{Cambria}A short test with the font Cambria and now a change to \fontspec{DejaVu Serif}\[Scale=0.85\] the font Dejavu and now at last \fontspec{Arial}[Scale=0.9\text{to the font Arial}].
```

A short test with the font Cambria and now a change to the font Dejavu and now at last to the font Arial.

As shown above, the correct font names can be found using various programs, such as `pdffonts`. Listing 4 shows the fonts used in the above example.

### 3 Font selection by name

Selecting a font by its symbolic name assumes the font can be found in one of the directories listed above. `XeLaTeX` and LuaLaTeX go different ways: `XeLaTeX` searches for its fonts with `fontconfig`; this library (`freedesktop.org/www/Software/fontconfig`) is included in `XeLaTeX`, while LuaLaTeX determines the fonts from a self-created font catalogue. However, the normal user does not have to be particularly interested in this.

```tex
\usepackage{fontspec}
\fontspec{Cambria}A short test with the font Cambria and now a change to \fontspec{DejaVu Serif}\[Scale=0.85\] the font Dejavu and now at last \fontspec{Arial}[Scale=0.9\text{to the font Arial}].
```

A test in the Iwona font and now a switch to the Kurier font and now to the Antykwa Poltawskiego font which doesn't look like Helvetica Neue.

Since LuaTeX manages its own cache for the fonts, there is a pause in the TeX run the first time it is called because this cache has to be created:

```bash
luaotfload db : Font names database not found, generating new one.
```

The following examples are marked with a filename in the margin. All example files can be downloaded from `https://tug.org/~hvoss/tb135.zip`. These are complete documents whereas in this article I show only the important parts of the preamble and document body, with the output in a frame below. All examples must be run with LuaLaTeX.
Listing 1: Searching for Times on my local system

$ luafindfont times

<table>
<thead>
<tr>
<th>No.</th>
<th>Filename</th>
<th>Symbolic Name</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Times New Roman Bold Italic.ttf</td>
<td>timesnewroman</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>2.</td>
<td>Times New Roman Bold Italic.ttf</td>
<td>timesnewroman</td>
<td>/System/Library/Fonts/Supplemental/</td>
</tr>
<tr>
<td>3.</td>
<td>Times New Roman Bold.ttf</td>
<td>timesnewroman</td>
<td>/System/Library/Fonts/Supplemental/</td>
</tr>
<tr>
<td>4.</td>
<td>Times New Roman Bold.ttf</td>
<td>timesnewroman</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>5.</td>
<td>Times New Roman Italic.ttf</td>
<td>timesnewroman</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>6.</td>
<td>Times New Roman Italic.ttf</td>
<td>timesnewroman</td>
<td>/System/Library/Fonts/Supplemental/</td>
</tr>
<tr>
<td>7.</td>
<td>Times New Roman.ttf</td>
<td>timesnewroman</td>
<td>/System/Library/Fonts/Supplemental/</td>
</tr>
<tr>
<td>8.</td>
<td>Times New Roman.ttf</td>
<td>timesnewroman</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>9.</td>
<td>Times.ttf</td>
<td>times</td>
<td>/System/Library/Fonts/</td>
</tr>
<tr>
<td>10.</td>
<td>Times_Sans_Serif.ttf</td>
<td>timesansserif</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>11.</td>
<td>TimesNewRomanMTStd-Bold.ttf</td>
<td>timesnewromanntstd</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>12.</td>
<td>TimesNewRomanMTStd-BoldCond.ttf</td>
<td>timesnewromanntstd</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>13.</td>
<td>TimesNewRomanMTStd-Cond.ttf</td>
<td>timesnewromanntstd</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>14.</td>
<td>TimesNewRomanMTStd-CondIt.ttf</td>
<td>timesnewromanntstd</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>15.</td>
<td>TimesNewRomanMTStd-Italic.ttf</td>
<td>timesnewromanntstd</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>16.</td>
<td>TimesNewRomanMTStd.otf</td>
<td>timesnewromanntstd</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>17.</td>
<td>TimesNewRomanPS-Bold.ttf</td>
<td>timesnewromansmt</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>18.</td>
<td>TimesNewRomanPS-Bold.ttf</td>
<td>timesnewromansmt</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>19.</td>
<td>TimesNewRomanPS-BoldCond.ttf</td>
<td>timesnewromansmt</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>20.</td>
<td>TimesNewRomanPSCond.ttf</td>
<td>timesnewromansmt</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>21.</td>
<td>TimesNewRomanPSCondIt.ttf</td>
<td>timesnewromansmt</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>22.</td>
<td>TimesNewRomanPSIt.ttf</td>
<td>timesnewromansmt</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>23.</td>
<td>TimesNewRomanPSStd.ttf</td>
<td>timesnewromansmt</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
<tr>
<td>24.</td>
<td>TimesNewRomanPSStd-Regular.ttf</td>
<td>timesnewromansmt</td>
<td>/Users/voss/Library/Fonts/Times/</td>
</tr>
</tbody>
</table>

luaotfload | db : This can take several minutes; please be patient.

Running the example above with \texttt{XeLaTEX} instead of \texttt{LuaLaTEX} will produce an error message because the fonts Iwona, Kurier, and Antykwa Poltawskiego will not be found by \texttt{XeLaTEX}, since a full file name is not specified. In the following example, the file name with an extension must therefore be specified for the first three fonts, whereas HelveticaNeue is still loaded via the name, since it is a system font in my local macOS system and not part of the \TeX{} distribution.

A test in the font Iwona and now a change to the font Kurier and now to most recently the font Antykwa Poltawskiego, which doesn't look like Helvetica.

The file extension can be specified using the optional argument \texttt{Extension} and a directory that is not in the normal search path using the \texttt{Path} option. In this case, however, only the specified font style is activated; in the following example, \texttt{\bfseries} does not display bold because no corresponding bold variant was declared or was not found by \texttt{fontspec}.

\begin{verbatim}
\usepackage{fontspec}
\setmainfont{BertholdWalbaumBook.ttf}
\end{verbatim}

A test with the Berthold Walbaum font:
A completely normal text in the old beautiful font, which was \texttt{\bfseries} embedded as TrueType.

The bold variant can be assigned using the optional argument \texttt{BoldFont}:

\begin{verbatim}
\usepackage{fontspec}
\setmainfont{BertholdWalbaumBook.ttf}
\fontspec{Iwona-Regular.otf} A test in the font Iwona and now a change to the font Kurier and now to most recently the font Antykwa Poltawskiego, which doesn't look like HelveticaNeue
\end{verbatim}

A test with the Berthold Walbaum font:
A completely normal text in the old beautiful font, which was embedded as TrueType.

Using OpenType and TrueType fonts with Xe\LaTeX{} and Lua\LaTeX{}}
Listing 2: Searching for a font with a special shape

$ luafindfont -i 4 "myriad & semibold"

<table>
<thead>
<tr>
<th>No.</th>
<th>Filename</th>
<th>Symbolic Name</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MyriadPro-Semibold.otf</td>
<td>myriadpro</td>
<td>/Users/voss/Library/Fonts/MyriadPro/</td>
</tr>
<tr>
<td>2.</td>
<td>MyriadPro-SemiboldCond.otf</td>
<td>myriadpro</td>
<td>/Users/voss/Library/Fonts/MyriadPro/</td>
</tr>
<tr>
<td>3.</td>
<td>MyriadPro-SemiboldCondIt.otf</td>
<td>myriadpro</td>
<td>/Users/voss/Library/Fonts/MyriadPro/</td>
</tr>
<tr>
<td>4.</td>
<td>MyriadPro-SemiboldIt.otf</td>
<td>myriadpro</td>
<td>/Users/voss/Library/Fonts/MyriadPro/</td>
</tr>
<tr>
<td>5.</td>
<td>MyriadPro-SemiboldSemiCn.otf</td>
<td>myriadpro</td>
<td>/Users/voss/Library/Fonts/MyriadPro/</td>
</tr>
<tr>
<td>6.</td>
<td>MyriadPro-SemiboldSemiCnIt.otf</td>
<td>myriadpro</td>
<td>/Users/voss/Library/Fonts/MyriadPro/</td>
</tr>
<tr>
<td>7.</td>
<td>MyriadPro-SemiboldSemiExt.otf</td>
<td>myriadpro</td>
<td>/Users/voss/Library/Fonts/MyriadPro/</td>
</tr>
<tr>
<td>8.</td>
<td>MyriadPro-SemiboldSemiExtIt.otf</td>
<td>myriadpro</td>
<td>/Users/voss/Library/Fonts/MyriadPro/</td>
</tr>
</tbody>
</table>

Font: myriadpro
Fonttype otf(system) --> | Regular | Bold | Italic | BoldItalic |

Listing 3: Printing OpenType features

$ luafindfont -o 2f "myriad & semibold"
(output from Listing 2 omitted)

Running otfinfo -f for font no.2

```
> otfinfo -f "Users/voss/Library/Fonts/MyriadPro/MyriadPro-SemiboldCond.otf"
```

aalt  Access All Alternates
case  Case-Sensitive Forms
cpss  Capital Spacing
dnom  Denominators
dnm   Denominators
dina  Terminal Forms
drac  Fractions
kern  Kerning
dlgl  Standard Ligatures
lnum  Lining Figures
numr  Numerators
onum  Oldstyle Figures
ordn  Ordinals
pnum  Proportional Figures
sinf  Scientific Inferiors
supr  Superscript
tnum  Tabular Figures
zero  Slashed Zero

\usepackage{fontspec}
\setmainfont{BertholdWalbaumBook}[
  UprightFont=*-Book,
  ItalicFont=*-BookItalic,
  BoldItalicFont=*-MediumItalic,
  BoldFont=*-Medium]

A test with the Berthold Walbaum font:
A completely normal text in the beautiful old font, which was \bfseries integrated as TrueType.

\usepackage{fontspec}
\setmainfont{BertholdImagoBQ}[
  Path=fonts/,
  Extension=.ttf,
  BoldFont=BertholdImagoMediumBook]

A test with the Berthold Imago font:
A completely normal text in the beautiful new font, which was integrated as \textbf{OpenType}. The font as \textit{Italic} and now additionally \textbfseries as a bold variant

5 Font families

In the following example, the fonts are only found using the base name BertholdImagoBQ, whereby this base name itself is not a font name. Therefore, a definition must also be made for UprightFont.

BertholdImagoBQ-Book.otf
BertholdImagoBQ-BookItalic.otf
BertholdImagoBQ-MediumItalic.otf
BertholdImagoBQ-Medium.otf

Entering the fonts via a name can be simplified when using LuaLaTeX if you work with the wildcard *. Then the part of the name that is the same for all variants needs to be specified only for the base name.

In general, defining the fonts and their associated features is very time-consuming if the naming of the fonts is not organized in such a way that the fontspec package can do the assignment itself.
There are many packages that relieve the user of this work. As of this writing, CTAN lists 61 packages which do all the font setting internally. Here are some of the more commonly-used ones (capitalized according to the .sty filename, as distributed): accanthis, Alegreya, bitter, cantarell, CharisSL, Chivo, CormorantGaramond, crimson, CrimsonPro, dejavu-otf, droidsans, droidserif, egaramond, garamondlibre, gfsneohellenicotp, imfellEnglish, kpfonts-otf, lato, lexend, libertinus-otf, librebaskerville, LibreBodoni, librecaison, linguisticspro, marathi, newpnext, newtxtext, noto, noto-serif, opensans, plex-otf, plex-serif, quattrocento, roboto, Rosario, sourceserifpro.

The complete list, with links, is available at https://hvoss.org/Books/fontpackages.html. For more information about any package, you can visit https://ctan.org/pkg/⟨name⟩.

We already differentiate between the TeX engines used and independently load the required font formats. Also, all font packages also load fontspec by default. As a final example, we show the main part of the package file Alegreya.sty:

\begin{verbatim}
\ifAlegreya@otf
  \RequirePackage{fontspec}
\else
  \RequirePackage{fontenc,fontaxes,mweights}
\fi

\ifAlegreya@otf
\setmainfont[...
\begin{verbatim}
\end{verbatim}

By virtue of this work in the package, the user need only write the \texttt{\usepackage} command shown below. In contrast, we use another font, Anonymous-Pro, for the typewriter text, for which there exists no font package and thus we have to use \texttt{\setmonofont} explicitly.

\begin{verbatim}
\usepackage{Alegreya,AlegreyaSans}
\setmonofont[FakeStretch=0.8,Scale=MatchLowercase]{AnonymousPro}
\end{verbatim}

The normal font is \texttt{Alegreya}, which is also possible as \texttt{\textbf{bold}}.\par
The sans serif is \texttt{Alegreya Sans}, which is also available in \texttt{\textbf{bold}}.\par
\texttt{\ttfamily} And the mono font is Anonymous Pro, which is yet again available as a \texttt{\textbf{bold font}}.\par
\texttt{\addfontfeature[FakeStretch=0.65]We can further condense the mono font; the \texttt{\textbf{bold version}} gets the same treatment.}

The normal font is ALEGREYA, which is also possible as \texttt{\bf}.\par
The sans serif is ALEGREYA Sans, which is also available in \texttt{\bf}.\par
And the mono font is Anonymous Pro, which is yet again available as a \texttt{\bf font}.\par
We can further condense the mono font; the \texttt{\bf version} gets the same treatment.