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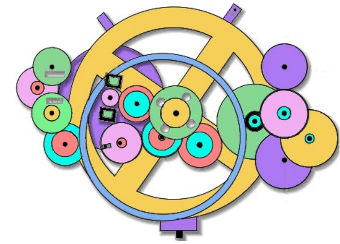

Relational Database Design
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DATABASE DESIGN NOTE SERIES

Evaluating Fonts for Multi-Lingual Documents
Multi-Script Database Series #4

Prepared by: A. Soler and F. Oberle

While not, strictly speaking, a database design issue, the incorporation of multi-script or even simply multi-lingual data into any user-accessible tables will often reveal deficiencies in business applications utilizing that data. Such applications include – among others – data entry front-ends, report writers, word processors, spreadsheets, and so forth.

In previous Database Design Notes in this series, we discussed adding the names آمنة , นัฐพงษ์, Jennifer, りく and आदित्या to our customer data. When the first sample invoices for their purchases are printed with names such as ▮▮, □ □ □ instead, or the even-more interesting �□▮, it won't take long before visitors with torches are at your door. What's worse, if your Arabic or Hebrew speaking customers find that their names use the right characters, but are spelled backwards, the torches may actually be lit. You provided the data, after all, so it must be your fault. The great violinist Schlomo Mintz (שלמה מינץ) might be amused if you spelled his surname as ץנים, but then again, he might not.

During the migration planning, therefore, you and the application developers (yes, you need to make them your allies) need to be armed with enough information to insure this doesn't happen. This Note will give you some background in the most common causes for such distortions, enabling you to track down some of the missing letters!

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See page 23 for information on other material from Antikythera Publications.

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Database Design Note Series on Multi-Language/Multi-Script Databases

1. Exploring Alphabets

2. Exploring Complex Text Layout

3. Exploring UTF-8

4. **Evaluating Fonts for use in Multi-Lingual Documents**

5. Exploring Bidirectional Text Entry

6. Evaluating Bidirectional Text Handling Behavior in Applications

Database Design Note Series – Evaluating Fonts for Multilingual Documents

WHY AND HOW TO EVALUATE YOUR ORGANIZATION'S FONT COLLECTIONS

This is primarily of interest to those who have encountered the dreaded "� ▯ ▮" and similar outputs described in the introduction, or who have experienced unwanted and occasionally bizarre font substitutions when creating multilingual documents. Such errant substitutions often occur when using more than one Script – a second alphabet if you will [1] – within a single document. Word processors such as LibreOffice Writer and Microsoft Word have a CTL (Complex Text Layout) feature that permits a user to explicitly define a separate font for a "second" Language that uses a "complex" Script but, even in such cases, it is not uncommon for that font to be replaced as well. [2] A common cause for such substitutions is the use of one or more incorrectly or incompletely formatted font files.

A little history may be helpful in understanding why this can occur: in the not-too-distant past, we were generally restricted to single byte characters, which meant a limited subset of two Scripts at a time. The first 127 characters would always be basic Latin (a, b, c, etc.), since that was a requirement for using the system at all.[3] European languages that used Latin assigned various supplemental characters to the upper 127 byte positions, while languages such as Thai would mix Latin's a, b, c with their own ก ข ฃ placed in the upper 127 positions. Support for more than two such sets simultaneously, however, was rarely possible. Support for the use of multiple Languages – sorting, hyphenation, spell-checking, grammar-checking, and so forth (not our concern here though) – was similarly limited.

The adoption of Unicode (specifically with its UTF-8 format) now permits computer operating systems to freely intermingle well over 100,000 characters and symbols, and recent advances in font technology, generally identified by some form of the term "Open Type" means that – in theory at least – additional specialized software [4] is no longer necessary to properly place the variety of accents, tone marks and vowels used by many Languages, nor to correctly combine and reorder neighboring characters as many Scripts require or even to display text in its intended direction.

In order to benefit from these advances, however, one critical requirement is the availability of up-to-date and properly formatted fonts that *not only contain the characters needed, but that also include any instructions required for the glyph manipulations referred to in the previous paragraph* – in other words, "Open-Type-capable" fonts.

There are web postings suggesting that all we need to do is locate and use fonts with an .otf extension, but this is at best a very misleading suggestion.[5] Here's the truth – in the form of a few propositions:

1. Fonts with full Open Type capabilities can be found in either .ttf or .otf formats and extensions. Really! The primary difference between the two extensions, by the way, is that .ttf fonts use Quadratic Bézier splines, while .otf fonts use Cubic Bézier splines (as older PostScript Type 1 fonts did).[6]
2. BUT: Not all fonts with a .ttf extension have Open Type capabilities, particularly older ones!

---

1 There isn't necessarily a one-to-one correspondence between Script and Language. A Script is a collection of glyphs representing characters and symbols and may often often be used by more than one Language; a particular Language may use all or part of a particular Script. Most western Languages use the Latin Script - each with a slightly different collection of characters. Some Languages use different Scripts in different contexts (e.g. Kazakh can be written left-to-right in Cyrillic Script or right-to-left in (a form of) Arabic Script; Serbian uses either Latin or Cyrillic Scripts.)

2 Since there may be no indication that has happened, here are two methods to determine if Writer (for example) has replaced a specified font: 1) choose "Save as" an .fodt file and then open that in a text editor; you can see what font is actually used by examining the styles. 2) choose "Export as .pdf"; many readers have a menu option to list the fonts the document contains.

3 This is more a matter of technical reality than cultural insensitivity; see the "Perceived Cultural Issues" section in *Exploring Complex Text Layout*, another Design Note available at http://www.AntikytheraPubs.com/i18n.htm for a more detailed explanation of how this came to be.

4 … and this includes the patronizingly named "Complex Text Layout (CTL)" support in some word processors.

5 Actually, it's just wrong! See http://superuser.com/questions/96390/difference-between-otf-open-type-or-ttf-true-type-font-formats for a description that, for me at least, has proven to match all my observations. Also see Appendix on page 22.

6 Some sources say that if an open type font lacks a digital signature – part of the OTF specification – it can't use an .otf suffix.

3. Fonts with a .ttf extension that report no Open Type capabilities may be outdated and no longer useful!

So why the unwanted character and font substitutions? Extremely few fonts contain all of the glyphs defined in the Unicode standard (after all, Coptic and Cuneiform symbols – to give just two examples – are not commonly required in most business activities). Because of this, operating systems and individual applications often use display and layout libraries[7] that will find any missing glyph in another font and transparently replace it. If multiple potential character or font replacements are located, the most suitable substitution is chosen by matching a variety of characteristics such as style, weight, etc. But: (there's always a "but," isn't there?)

Even the best of these utilities are subject to the old data processing maxim "Garbage in = Garbage out" – the infamous "GIGO" syndrome. More fonts than you might expect don't report their capabilities completely or correctly; older fonts in particular had no need to do so. Furthermore, older fonts that stored non-Latin characters in the upper 127 bytes will continue to "work" just fine with Latin Scripts, even though current systems will look for those non-Latin characters elsewhere. Where the particular font is a user favorite, or a corporate-mandated font, you will need to muster not only your technical skills, but your political ones as well. If the desired font fails to report its capabilities correctly (or at all), it may fall victim to these no-longer-mysterious replacements or mysterious □ □ characters!

So, for example, if we need to combine Greek, Thai, and Hindi in a single document, we would ideally need – aside from normal stylistic considerations of course – to be able to ***easily*** find a font or font family that: a) contains an aesthetically compatible collection of all the characters needed and: b) correctly ***reports*** which Languages and Scripts it supports, i.e. a font with Open Type capabilities. In practice, accomplishing this can be quite tedious![8]

As for the "ideal need" postulated above, many applications exist – from simple utilities to full-blown font editors – that look within single fonts. But very few will look through several at once[9]; none have an option to restrict their output to just what support is reported for specific Script(s).

Hence, the development of the primitive (but hopefully useful) shell script included at the end of this paper. Rather than relying on what the fonts report to various utilities, it traverses through all of the fonts to locate those containing a representative set of characters from the Scripts of interest, and only then uses standard utilities to determine what those fonts report. The resulting output is then used to further evaluate any potentially suitable fonts, as well to identify fonts that might (or probably) need to be replaced, repaired, or discarded.

The `FindFont` script is run from the command line. It is *not* "comprehensive", but there are enough Language and Script examples in its main *case* section that it shouldn't be very difficult to add the aforementioned Coptic and Cuneiform definitions should such a need arise. In order to determine which installed fonts have full support for Greek, Thai, and Hindi (our earlier example), the command "`FindFont greek Thai hindi`" will provide a list, and include the level of support reported by each font. "`FindFont farsi Laotian`" is another example.

The script is heavily commented, so a little reading will suffice to clarify what it's doing and what options are easily changed (e.g. where the script looks for the fonts). If you need to add other Scripts (quite possible if your needs differ from ours), you will also need to add new "cases" to the Bash script's `convertKeyWord()` routine. The only potentially confusing part is how the `CharMap` variable – a regular expression – for each of the Languages/Scripts is constructed. Regular expressions are certainly well documented (although not always consistently implemented); it is the layout of the targets to be matched that may not be intuitive, so it may help to describe what the `$CharMap` variable is intended to match in a little more detail.

---

7 Commonly used libraries for this purpose include Harfbuzz and Pango on Linux machines, CoreText/CoreGraphics on Macs, and Uniscribe on Windows. As one might expect, these generally produce identical results, but with enough differences to keep life interesting for those sharing documents across platforms.

8 Custom corporate fonts that are rendered incompatible with Unicode standards should be identified as soon as possible so that a competent font designer (or at least someone who can use a font editor to relocate characters to their "new" location – the bare minimum requirement) can begin to analyze and address the issue, including creating a transition plan.

9 Of those that do, Fontaine is the most comprehensive I'm aware of – its one drawback (for many) is that it is only available as source code, and requires compilation: see https://sourceforge.net/projects/fontaine/files/latest/download for more information.

Each modern font should contain a bitmap – a set of single bits representing each of Unicode's variety of glyphs; a "1" bit indicates the glyph is contained in the font while a "0" means that it isn't. Simple enough. Surprisingly (to me anyway), a number of fonts on my system that actually contain glyphs/characters did not report them in the bitmap.

The `fc-query` utility, used by FindFont to extract the bitmaps, returns one or more lines, each consisting of an offset value followed by eight (8) thirty-two bit words arranged in four bytes each. Here is an example of one such line:

```
000e: fffffffe 87ffffff 0fffffff 00000000 fef02596 3bffecae 33ff3f5f 00000000
```

This line displays the 256 bits representing the presence or absence of Unicode glyphs/characters in slots `0x0e00` through `0x0eff`. Although these 32-bit words are not numeric values, they are nonetheless laid out as if they were. As an example of how this affects creation of suitable regular expressions, assume that we wish to locate a font whose bitmap indicates support for the Thai Script plane, defined in the Unicode standard as "0E00-0E7F"[10] and from which the Thai alphabet is formed. Not all slots in that plane are assigned, however, as can be seen in the partial segment of the chart on the right, which shows that no glyph is assigned to `0x0e00`.

Thai

Segment of page 2 from: http://unicode.org/charts/PDF/U0E00.pdf

	0E0	0E1	0E2	0E3	0E4
0		ฐ 0E10	ภ 0E20	ะ 0E30	เ 0E40
1	ก 0E01	ฑ 0E11	ม 0E21	◌ั 0E31	แ 0E41
2	ข 0E02	ฒ 0E12	ย 0E22	า 0E32	โ 0E42
3	ฃ 0E03	ณ 0E13	ร 0E23	ำ 0E33	ใ 0E43

It is also true that no characters are assigned by the standard to the ranges "`0x0e3b-0x0e3e`" or "`0x0e5c-0x0e7f`" although both are reserved for future use by the Thai Script.[11] What we want, therefore, is to locate a bit map segment in a row that a) begins with "`000e:`", and b) contains 1 bits in each of the defined character positions.

Furthermore, we need to ignore the irrelevant bit values in the row, which could be either 1 or 0. Complicating this somewhat is the fact that we need to effectively translate each nybble (single hex character) into its four component bits. It bears repeating that these are not values: the hex nybble "`8`" is not a value of 8, nor does it represent a "required-ignore-ignore-ignore"[12] (1-0-0-0, since a hex "`8`" is a binary `1000`) sequence, but a 0-0-0-1 "ignore-ignore-ignore-required" sequence: the bits in each nybble are read from right to left! An example will illustrate how this works for the output line containing the bitmap for Thai Script given earlier. Follow along with the chart on page 7, as following this can be intricate if you've never used such a bitmap.

Recall that we need to eliminate `0xe00` from consideration, but insure that `0x0e01` through `0x0e03` contain a 1 value. The first nybble must therefore be a "required-required-required-ignore" (1-1-1-0) sequence. Carrying this further, the next twenty-eight bits (seven nybbles), representing `0xe04` through `0xe1f` must all be set to "1" as well. Thus the regular expression that will find a potentially valid matching line in the `fc-query` output would begin with:

"`000e:[[:space:]]fffffffe`"

But we should continue with the remainder of the desired pattern. According to the Thai Unicode chart, we need "1" bits in positions `0x0e20` through `0x0e3a` and in `0x0e3f`. The twenty-four bits (six nybbles) from `0x0e2a` *down to* `0x0e20` can be represented as `ffffff` but remember: these are the *rightmost* characters of the second word.

The second nybble from the left in the second word, representing just three required glyphs (`0xe3a` *down to* `0xe38` – we don't care about the undefined position `0x3b` so we can ignore it) means an ignore-required-required-required sequence (0-1-1-1, a hex "`7`"), so the hex nybble "`7`" needs to be added.

To complete the beginning of the second word, we include a required-ignore-ignore-ignore sequence (1-0-0-0, a hex "`8`") for the `0x0e3f` character. The regular expression now looks like:

"`000e:[[:space:]]fffffffe[[:space:]]87ffffff`"

---

10 See http://unicode.org/charts/ to view or download official Unicode charts, look up code points by number, etc. Note that the output of `fc-query` does not use capital letters for hex characters, so the regular expressions use only small letters.

11 Observant readers will note that this example line also encompasses Laotian, since the Unicode standard places that Script in the "0E80-0EFF" plane. In this example, the Thai and Laotian portion of the font's bitmaps are completely contained within a single line. It isn't always so easy.

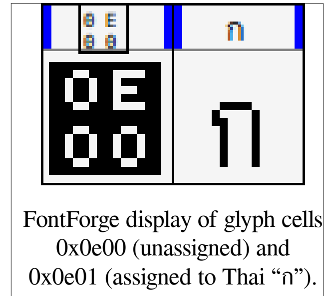
12 That is to say that we *require* the presence of the glyph/character represented by the `1` bit, but we don't care about the `0` bits, which may be `1` or `0`. We'll clarify the "don't care" category later when the `unifont-9.0.03.ttf` font is mentioned.

Finally, to complete our entire regular expression pattern, we note that the final required characters (from `0xe5b` *down to* `0xe40`) occupy exactly 28 bits of the third word's 32 bits (96-65); these make up, as should be apparent by now, the rightmost seven nybbles of that third word. The regular expression looking for complete coverage of the defined Unicode plane for Thai now looks like:

"`000e:[[:space:]]fffffffe[[:space:]]87ffffff[[:space:]]0fffffff`"

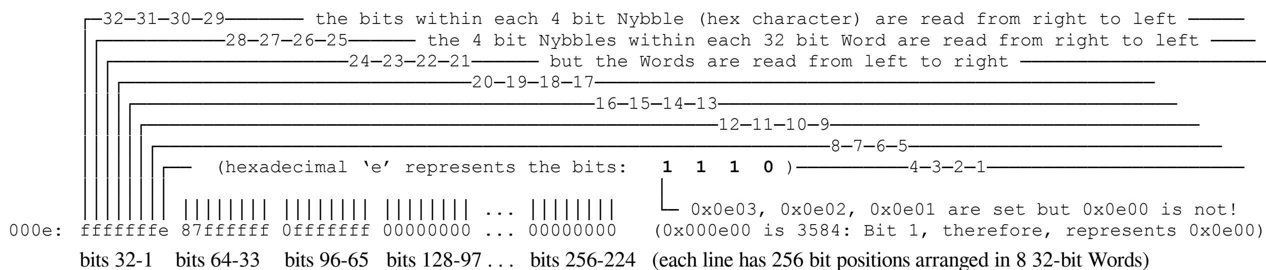
Those with grep experience will likely wonder why the "`e`" in the initial "`fffffffe`" sequence is not represented by a "`fffffff[ef]`" sequence. It might seem that, if we *really* don't care what the "don't care" bit is, the presence of an "`f`" would be acceptable as well. The truth is, though, that we do care just a little; in this particular example, the reason is that no glyph is defined to occupy the 0x00e0 position. We're then faced with the question: "If there's something there, what is it?" Such a font should not "pass" our testing unless and until this and the obvious related questions have an answer. Something is strange and, as data custodians, our instinct should be to figure out what's going on!

It so happens that the very interesting pan-Unicode font `unifont-9.0.03.ttf` fails our testing for just this reason; the first segment of the relevant the `fc-query` output line is `ffffffff` rather than `fffffffe`. Although this font contains all of the Thai characters (as well as every other character), each of the unassigned positions contains something like one of the characters mentioned above, but with an embedded hex code. The font itself is terrible looking – reminiscent of a really poor dot matrix printer from decades ago – and is totally unsuitable for printing documents and reports. So why mention it at all? Simply because it is a great "testing" font, and is also a very efficient way to determine what some of the "�▮" characters on any failing tests were actually supposed to be.



FontForge display of glyph cells 0x0e00 (unassigned) and 0x0e01 (assigned to Thai "ก").

Here is a more graphic representation of the Thai portion of the Unicode plane:



A much more detailed examination of this line is presented in the chart on the following page and includes the Laotian bit map – which, you'll recall, also occupies the `000e:` line – as well as the Thai Script. This will show how the string

"`000e:[[:space:]01-9a-f]\{37\}fef02596[[:space:]]3bffecae[[:space:]]33ff3f5f`"

was derived as a regular expression to confirm the reporting of the Laotian Script bitmap in a font.

A final example, shows an `fc-query` output line (`0005:`) covering multiple Unicode planes (Cyrillic Supplement U0500-U052F), Armenian (U0530-U058F), and Hebrew (U0590-U05FF); note that Yiddish also uses characters from the Hebrew Script plane, as does Biblical (or chanted) Hebrew, which uses even more glyphs in the U0590-U05FF plane!

Whether or not you intend to use Thai, Laotian, Cyrillic, Armenian, Hebrew or Yiddish, studying these examples will give you enough familiarity with the process that you'll be able to add most other Scripts you may need.

Other Activities

If your organization has a collection of older documents – reports and so forth – that were created using non-Latin Scripts, but built with older fonts, you may need to undertake a conversion of their data to Unicode/UTF-8 as part of any conversion effort.

Such an effort is not in the scope of this document, but there are numerous resources available for accomplishing this; whether any conversion needs to be done, and whose responsibility that is, however, may involve some interesting discussions.

Following the latter example chart is the complete text of the `Find-Font` shell script. Copy it from this pdf into a separate text file, make it executable, and experiment, changing variables as required. Feedback is welcome!

Bash Script for Evaluating Font Collections against one or more Languages

The script below should run on any contemporary Linux system. Copy the script into a new text file, name it `FindFont` (or whatever works for you). Placing it in a location that is already part of your $PATH will make life easier, and be sure to set the execute flag (e.g. using “`sudo chmod`” or an equivalent command from a file manager GUI). Instructions are found in the early comments of the code itself as well as in the earlier part of this document.

```
#!/bin/bash
# FindFont - Find all Fonts containing one or more specified characters;
#            Frank Oberle แฟรงค์โอเบอลีทำนี้: November 2016; support for Korean added in April 2018
#            This searches through each .ttf or .otf in some specified directories (see Where2Look below) to
#            find and list all fonts containing a defined set of characters. Several other attributes of each
#            "matching" font are listed as well.

# PURPOSE:   It is often useful to easily determine which fonts have support for one or more scripts and,
#            how correctly each of those fonts reports its support to an operating system or application.
#            If, for instance, it is necessary to combine Greek, Thai, and Hindi in a single document, it
#            would be ideal to locate which fonts support all of these in order to achieve some level of
#            "harmony." Unfortunately, even though many utilities exist to look within single fonts, I've
#            found none that would look through several at once. Furthermore, a significant number of fonts
#            don't correctly report which languages or scripts they provide support for (those mean quite
#            different things, but that's outside the scope of a shell script comments section). Hence, this
#            primitive, but useful shell script.
#            Fonts that don't correctly report their contents and capabilities are often subject to being
#            unceremoniously replaced by word processors such as Libre/OpenOffice Writer and others.

# ALSO:      By default (but can be changed by setting variable values at the beginning), the script will
#            generate separate text files: one containing a simple list of all matching fonts that report all
#            of their capabilities correctly, and another containing a list of fonts that may have structural
#            problems causing them to report their capabilities incorrectly, incompletely, or not at all.
#            This latter should be reviewed to determine if these fonts should be repaired or replaced.
#            This also generates an .fodt file (listing the "matching" fonts) that can be loaded into a word
# (optional) processor as the basis for a "font sample" document. Unfortunately, although many available
#            word processors can open and read .odt files, there are none I'm aware of that will permit all
#            of the fonts to be displayed correctly, making this a somewhat quixotic effort.
#            LibreOffice Writer, for instance, "helps" out by making apparently random substitutions of the
#            fonts when it encounters a "foreign" character set/language or whatever and, even worse, gives
#            no indication at all that it has done so. Combined with a slavish conformity to the rather odd
#            and illogical "Complex Text Layout" (CTL) definitions, creating such a "font sample" document
#            in such a word processor is far more of a bother than it ought to be. Nonetheless, if you have
#            a "publishing" application, the generated .fodt file may be useful as a starting point.

# DEPENDENCIES: The utility ttfdump, installed or available with most Linux distributions and Windows.
#               The utility fc-query, available for most Linux distributions and many Windows versions
#               A minimal understanding of the differences among languages, scripts, characters and glyphs;
#               one reason for this is so that you don't become confused by my blatant disregard for those
#               distinctions in order to achieve my immediate goals !!
#               To add new Script or Language definitions to this script, some knowledge of how to construct
#               regular expressions is necessary. A pdf document was supplied with this script that explains
#               the layout of the targets the regular expressions are intended to match.
#               Finally, the Bash shell, of course. This script should work with any recent version of Linux
#               and may even work with Microsoft's new bash shell for Windows, since the other utilities
#               mentioned above are also available for Windows.

# USAGE: Right now, this is called as FindFont [1st script/language] [2nd script/language] [3rd ...] etc.
#        See the convertKeyword() routine below to define what "script/language" means; note that you may
#        need to add to this "case" statement to suit your own needs. Comments there will (maybe) explain
#        how. If no parameter is given, this will by default search for fonts containing Thai Unicode
#        characters; for most users, it probably makes more sense to simply have the script produce usage
#        instructions in such a case, but I did this for my own selfish purposes so it doesn't. It's easy
#        enough to change the "if [ $# == 0 ]; then" section in the MAIN SCRIPT DEFINITION ROUTINE below if
#        you wish to do so.
#        Currently recognized arguments are these: (case-insensitive, but require a minimum of 4 characters)
#        Arab[ic],  Arme[nian],  Bibl[ical (Hebrew)], Cyri[llic],  Deva[nagari], Fars[i],     Gree[k],
#        Hebr[ew],  Hind[i],     Iran[ian],           Laot[ian],   Pers[ian],    Russ[ian],   Thai,
#        Yidd[ish], Box Drawing, Curr[ency],          Domi[noes],  Frac[tions],  Liga[tures], Musi[c]

# BUGS: Test Characters and Test Sample Strings in Right-to-Left (RTL) scripts such as Arabic and Hebrew are
#       handled poorly when assigned to Bash variables. The order of characters in the search list is
#       reversed, and the order of the words in Sample strings is reversed, although the order of the
#       characters within the words is maintained. I lost patience attempting to figure out a work-around so
#       just be aware that it occurs. It really doesn't affect the purpose of this script as I use it.

# References:
#   Evaluating Fonts for use in Multi-Lingual Documents             # Document explaining this shell script
#   http://unicode.org/charts/                                      # View/download official Unicode charts;
```

```
#                                                                   #   look up code points by number, etc.
#   My own rants:
#     https://bugs.documentfoundation.org/show_bug.cgi?id=92655     # Relevant pdf attachments on this link:
#                                                                    > "General discussion of Complex Text...
#                                                                    > "Detailed steps to reproduce the bugs.
#   A very nice additional rant from someone I've never met:
#     https://eev.ee/blog/2015/05/20/i-stared-into-the-fontconfig-and-the-fontconfig-stared-back-at-me/
#                                                                   #   look up code points by number, etc.
# Pan-Unicode Fonts: These are usually way too large to be of any practical use, but as a benchmark when you
#                    need to see something without worrying about whether the font contains a specific
#                    glyph, having one or two of these available can be helpful.
#   http://unifoundry.com/unifont.html                              # Font containing utilitarian (read:
#                                                                     ugly) representations of more Unicode
#                                                                     characters/glyphs than any other font.
#   www-sul.stanford.edu/depts/sysdept/info/CODE2000.TTF            # Code2000, 2001 & 2002: better looking
#                                                                   # and almost as comprehensive as Unifont.
#

####### OPENING: Check if ttfdump and fc-query are installed and, if not, exit with an appropriate message.
if ! ttfdumpExists=$(which ttfdump); then                           # If ttfdump utility is not installed
  echo "The ttfdump utility is required but can't be located."      # Display a warning message
  echo "If it's not installed, try running:"                        # Display a suggestion to the user
  echo "   sudo apt install ttfdump"
  echo " (or use whatever package command is appropriate for your distro, e.g. pacman, yum, etc.)"
  echo "For newer distros, you may need to install a more complete package with:"
  echo "   sudo apt install texlive-binaries"  echo "Otherwise, check your path."
  exit                                                              # End the Script without going further
fi

if ! fcqueryExists=$(which fc-query); then                          # If fc-query utility is not installed
  echo "The fc-query utility is required but can't be located."     # Display a warning message
  echo "The fc-query utility is part of the fontconfig package"
  echo "Try running:"                                               # Display a suggestion to the user
  echo "   sudo apt install fontconfig"
  echo " (or use whatever package command is appropriate for your distro, e.g. pacman, yum, etc.)"
  echo "Otherwise, check your path."
  exit                                                              # End the Script without going further
fi

#if ! fcqueryExists=$(which Fontaine); then                          # If the Fontaine app is not installed
#  echo "The Fontaine application is not installed."                 # Display an informational message
#  echo "Fontaine is not required for this script, but can be useful in analyzing font(s) of interest"
#  echo "without the need to use a full-blown font editor such as FontForge."
#  echo "If you are willing and able to compile it, the source code can be freely downloaded:"
#  echo "   For information, see  http://www.unifont.org/fontaine/ - OR - to download it directly"
#  echo "                  go to  https://sourceforge.net/projects/fontaine/files/latest/download"
#fi

#### VARIABLE DECLARATIONS    # The basics
           Origin=$(pwd)                                            # Save current directory so we can return
           debug='oFf'                                              # Set to 'ON' to debug certain sections
#           Where2Look=$(echo ~/.fonts)                             # Check only User-specific fonts
#           Where2Look=$(echo /usr/share/fonts/truetype)            # Check only for system fonts (all users)
           Where2Look=$(echo ~/.fonts /usr/share/fonts/truetype)    # Linux std locations; modify as needed
#           Where2Look=$(echo ~/Documents/Fonts_All)                # My own stash of uninstalled fonts
           Verbosity=1                                              # How much info to report (1, 2, 3)
                                                                    # Currently not implemented
           FODTGen=1                                                # Generate an .fodt file listing fonts
                                                                    # '1' turns it ON; anything else OFF
           FODTDOC="TestDoc"                                        # Created as $Origin/TestDoc.fodt in the
                                                                    #     directory where script was started
           FPassGen=1                                               # '1' creates a file listing 'good' fonts
           LLFN="PASS"                                              # LangListFileName name completed below
           SuspectGen=1                                             # '1' creates listing of 'suspect' fonts
           SFLFN="SuspiciousFonts.txt"                              # SuspiciousFontListFileName

# Not all of these need declaration in BASH, but just in case someone attempts to convert this to a real app
                              # Number of Arguments passed to this script on the command line
declare -i CMIdx                                                    # Int counter for number of arguments
declare -i NumArgsAccepted                                          # Int counter for upper # of args
           NumArgsAccepted=6                                        # ARBITRARY; this is all I ever use ...
declare -i ArgsFound                                                # Integer counter: Number of args passed
           ArgsFound=0                                              # ArgsFound Counter initialized to 0
                              # Number of Fonts examined
declare -i FontsChecked                                             # Int counter for # of fonts examined
           FontsChecked=0                                           # FontsChecked initialized to 0
declare -i FontsMatched                                             # Int counter for # of matching fonts
           FontsMatched=0                                           # FontsMatched initialized to 0
                              # Number of Language Codes examined
declare -i LangIdx                                                  # Pointer for Per-Font Language Arrays
```

```
declare -a LangAbbrevList                                            # Array of lang codes to be looked for
declare -a LangList                                                  # Per-Font Array of found lang Keywords
declare -a LangsMatched                                              # Array of matching langs
declare -i LangMatchFailures                                         # Int counter for # of unmatchedlangs
           LangMatchFailures=0                                       # LangMatchFailures initialized to 0
declare -i FinalLangCount                                            # Integer value for counting langs found
                              # Number of Open Type Capability Matches and Failures
declare -i OTCapIdx                                                  # Tracks OT capabilities in each font
declare -a OTFMatches                                                # Array of OTF Capabilty Matches
declare -a OTFMatchFailures                                          # Array of Open Type Tag
declare -i MissingOTFMatches                                         # No of Missing Open Type Capability Tags
           MissingOTFMatches=0                                       # Initialize Missing OTF Tags to 0
                              # Number of Character Map Matches and Failures
declare -a CMapsMatched                                              # Array of OTF Capabilty Matches
declare -i CMMatchSuccesses                                          # No of Character Map Match Successes
declare -i MissingCMMatches                                          # No of Missing Character Map Entries
           MissingCMMatches=0                                        # MissingCMMatches initialized to 0
declare -i CMapMatchFailures                                         # Int counter for # unmatched charsets
           CMapMatchFailures=0                                       # CMapMatchFailures initialized to 0

declare -i FullMatchListIdx                                          # Tracks full matches over all fonts
           FullMatchListIdx=0                                        # Int counter for # full matches
declare -i FullMatchFlag                                             # Tracks full matches over each font
           FullMatchFlag=1                                           # Assume success until a failure for each
declare -a FullMatchList                                             # List of fonts showing all requirements
                              # Cosmetic stuff for screen output
           MajorSeparator=$(printf "=%.0s" {1..128})                 # For beginning and end of entire report
           MinorSeparator=$(printf "~%.0s" {1..128})                 # For separating each font rpt section
           MiniSeparator=$(printf "~%.0s" {1..106})                  # For separating each summary section
           # 36 chars right just; 4 digits right just; open string; line feed
           Fmt="%36s %-4s %s\n"                                      # For use with printf statements below

# Bash doesn't preprocess scripts, so functions like writeSample(), convertKeyword(), and inspectFont() must
# be defined before they are called ...

# writeSample() writes a sample line/section for each font found to contain the specified character(s) to the
# fodt output file which will serve as the basis for creating a word processor font sample document.
# It assumes that the file has been opened; any other parts of the file are written in line below. This
# function is only called in statements controlled by the value of the $FODTGen variable.
writeSample()                                                        # Only required for .fodt creation
  {
  echo -e "   <text:p >$1</text:p>"                 >> $DemoDoc   # Add this file to our output fodt
  # Note the no-break spaces (0x00a0) after <text:p > below; this is so LibreOffice doesn't discard them !
  echo -e "   <text:p >     $2</text:p>"            >> $DemoDoc   # List actual characters to output fodt
  echo -e "   <text:p >     $3</text:p>"            >> $DemoDoc   # Add the font Slant, Weight and Width
  echo -e "   <text:p >     Sample Text:$4</text:p>"  >> $DemoDoc   # Add sample text to our output fodt
  echo -e "   <text:p/>"                            >> $DemoDoc   # Add a blank line after each font name
  }                                                                  # White space ignored by LO-Writer

# convertKeyWord() interprets a processed (uppercase & trimmed) KeyWord to create various required values ...
# Here we can define some scripts of interest; in this context the Script name is used as the variable name,
#      but we could just as easily give the variables Language names if that makes more sense in context.
#      This is really cheating, since we're only looking for representative character(s) from particular
#      Script(s) - which can be misleading, as many Greek characters are present for use with Mathematics
#      even when full Greek language support isn't present. See comment under "CYRL" in the case statement.
# CASE Statement: For testing I've used arbitrary 4 letter abbreviations; this could probably be refined to
#                 use ISO 639 two (639-1) or three (639-2) character language codes for convenience, although
#                 we're really looking for a particular Script here rather than a particular Language. For
#                 quick and dirty purposes, this will suffice for now. (Cyrillic, for instance, is not a
#                 Language, but is a Script used by several Languages, each of which may have its own ISO 639
#                 language code.)  See "MAIN SCRIPT DEFINITION ROUTINE" below.
# HexCode: These are the hex codes in 0x0000 format representing Unicode values of representative sample
#          characters that we will search for. This will give a somewhat independent view of what Script(s)
#          each font contains.
# TestChar: These are the actual Unicode glyphs assigned to the $HexCode values above: There are no checks to
#           see that these actually match those glyphs, so be warned!
# CharMap: A bitmap is contained in each font where each bit represents one possible position defined by the
#          Unicode Standard (http://unicode.org/charts/). A "1" bit means the character is present while a
#          "0" indicates that it isn't. The output from fc-query is arranged in rows of eight (8) thirty-two
#          bit words arranged in four bytes each. These bytes (0x00-0xff) do not represent values but simply
#          positions, so are interpreted differently than you might expect. At the start of each row is an
#          offset value: if, for example, that value is "000e:" then the bits in that row indicate the
#          presence or absence of Unicode positions 0x0e00 through 0x0eff. Note that if no bits in the range
#          of a particular offset value are set, that row is simply not included in the output. Typically,
#          a row defines the presence of assignments from one to three or more Unicode Planes.
#          $CharMap is a regular expression to determine if appropriate matching lines exist.
#          Examples of how these are formed are given in comments at the end if I remember to include them.
# Lang: This is an entirely arbitrary designator that I use for my own convenience; in some cases it isn't
#       even a language at all. Neither "Cyrillic" nor "Devanagari" for instance are Languages, but Scripts;
#       and "Ligatures" and "Box Drawing" certainly aren't Languages either. It's just a mnemonic for me.
```

```
# LangCode: RFC-3066 is the source for the Lang(uage) Codes used below and by the Linux fc-query utility; for
#           sample listings and values, see https://www.w3.org/International/articles/language-tags/
#           For Region & Language Codes, see: http://www.i18nguy.com/unicode/language-identifiers.html
#           For Language Tags: https://www.microsoft.com/typography/otspec/languagetags.htm
#                          and: https://www.microsoft.com/typography/otfntdev/standot/features.aspx
# ScriptTag: Part of "capability:" section as reported for a fonts when using fc-query
#            ISO 15924: 4 char Alpha Script Codes: http://www.unicode.org/iso15924/iso15924-codes.html
#                I am using: otlayout:arab  otlayout:cyrl  otlayout:dev2  otlayout:deva otlayout:grek
#                            otlayout:hebr  otlayout:musc  otlayout:thai  (Only the last four letters!)
#            ISO 15924: 3 digit Script Codes: http://www.unicode.org/iso15924/iso15924-num.html
#            See a list at: https://www.microsoft.com/typography/otspec/scripttags.htm
#            Because the definitions of OFF/OT script tags predate ISO 15924 and Unicode Script property
#            assignments, the script tags provided by the fonts don't always conform to ISO 15924. The
#            resolution of conflicting proposals also resulted in alternate tags that essentially refer to
#            the same Unicode script definitions: for example, ‘deva’ and ‘dev2’ are virtually the same.
#            Script Tags supposedly indicate the font's ability to properly arrange characters that are
#            formed from more than one glyph*: a Thai character that needs to have both a vowel and a tone
#            mark above it; such placement needs to be altered if only one of those is required. It is very
#            important to remember that that - even if the font reports this ability for a certain script,
#            it doesn't imply that it does this rearrangement very well - but that's another issue.
#            * including: composition, decomposition, substitution, smallcaps, alternates, ligatures, et al.
# Sample: A sample word or phrase in characters of the Script/Language we are examining; this is used to
#         demonstrate certain capabilities if applicable; otherwise it's just that: a sample of the script.
#
# ISO 15295, which gives both 4 letter and numeric codes, is certainly more appropriate for this utility,
#    but the likelihood of a typical user knowing these is rather low, so I didn't attempt to do that.
#    To make things more interesting, many Unicode planes contain glyphs that are not really part of any
#    spoken language; there are no ISO 15295 script codes for Box Drawing characters, Emoji, Musical Symbols
#    and similar. So modify this listing to suit whatever identities you wish; just remember to also modify
#    the Keyword input translation sequences in the next section to suit what you are using.
convertKeyWord()
  {
   case "$1" in                                                  # Evaluate 1st (only) arg passed in ...
    "ARAB" ) HexCode="0x0639 0x0633 0x0626"                      # Only chars from basic alphabet
             TestChar="ع س ئ "                                   # N.B. MUST USE NON-BREAKING SPACES!
             # The following pattern looks only for the basic (ISO 8859-6) Arabic alphabet which, although
             # insufficient for "real-world" use, is all that's needed for the purposes of this script.
             CharMap="0006:[[:space:]01-9a-f]\{11\}[7f][f]\{5\}[ef]"                        # 258/32/15/32/32
             Lang="Arabic"
             LangCode="ar"                                       # Arabic (ISO 639-1)
             # fc-match uses only 'ar': The following are regional language versions:
             # ar-LB ar-LY ar-MA ar-MR ar-OM ar-PS ar-QA ar-SA ar-SD ar-SO ar-SY ar-TD ar-TN ar-YE
             # ar-AE ar-BH ar-DZ ar-EG ar-IL ar-IN ar-IQ ar-JO ar-KW
             ScriptTag="arab"
             Sample="هو مكتوب لي النصي عينة في العربية"          # "My sample script is written in Arabic"
                                                                 # RTL Words are reversed when $assigned
             # What that means essentially is that on a terminal output, the RTL Words, although having their
             # letters arranged correctly from right to left, are themselves written left to right. In the
             # fodt file, however, they are shown correctly. I attempted to "fix" this in a number of ways,
             # e.g. by wrapping the Arabic between RLE (0x202b) or RLO (0x202e) and PDF (0x202c) codes (see
             # http://www.unicode.org/reports/tr9/) but gave up trying, since it really didn't affect the
             # purpose for which this script was intended. See comments in other Right-to-Left Scripts.
             # Arab/160: Arabic Script Unicode blocks: 0x0600-; 0x0750-; 0x08a0-; 0xfb50-; 0xfe70-
         ;;
    "ARME" ) HexCode="0x0580 0x0583 0x0587"                                                 # 258/31/31/16/30
             TestChar="ր փ և"                                    # N.B. MUST USE NON-BREAKING SPACES!
             CharMap="0005:[[:space:]01-9a-f]\{10\}fffe[[:space:]01-9a-f]\{5\}fe7[[:space:]f]\{13\}e"
             # Interestingly, of the 31 fonts on my system that contain the test characters ($TestChar above)
             # as well as the language code "hy" ($LangCode below) all but 1 match this pattern. The one that
             # doesn't match is DejaVuSans-ExtraLight.ttf, which is missing the 0x0559 character ("Armenian
             # modifier letter left half ring" to use the Unicode term), making the "fe7" portion of the
             # CharMap pattern "fc7" instead. All 21 of the other DejaVu fonts on my system have this glyph
             # but I haven't pursued why that might be, since I don't use Armenian. I've included Armenian
             # only because it shares an fc-query output row (0005:) with Hebrew, and Hebrew is one of the
             # examples in my pdf "Evaluating Fonts for use in Multi-Lingual Documents" which explains how
             # to interpret/filter these lines using grep.
             Lang="Armenian"
             LangCode="hy"                                       # Really! I don't know the origin of "hy"
             ScriptTag="armn"
             Sample="Ինչ եք խոսում են հայերեն:"                  # "Do you speak Armenian?"
             # Armenian Script Unicode block: 0x0530-0x058f; Armenian Ligatures are 0xfb13-0xfb17
             # Note that Armenian Script is also known as Mesropian Script after its creator.
         ;;
    "BIBL" ) HexCode="0x05d0 0x05d3 0x05d8 0x05dd 0x05e9 0x05a3 0x05b3"                     # 258/6/4/6/6
             # This finds fonts with the Hebrew Alphabet AND Cantillation Marks 0x0591-0x05af (טעמי המקרא)
             # $TestChar does not include the cantillation marks referenced in $HexCode above because they
             # are very difficult to see without being "attached" to a "supporting" character. If such a
             # character is used (as in $Sample below), it confuses bash anyway as each is really two
             # characters. That's why the mismatch (7 hex codes and only 5 test characters)
             # Since the script only actually looks at the hex codes, this really makes no difference.
```

```
        TestChar="ש ם ט ד א";                                   # N.B. MUST USE NON-BREAKING SPACES!
                                                                # RTL Chars are reversed when $assigned
        CharMap="0005:[[:space:]01-9a-f]\{37\}fffe[[:space:]01-9a-f]\{5\}ffff"  # Cosmetic concatenation
        CharMap=$CharMap"[[:space:]01-9a-f]\{14\}00[[01]\{1\}[[078f]\{1\}07ff"  #  for printing source
        # Regarding the [078f] portion of the pattern above: in addition to the alphabet, a value of:
        # : 7 (0 1 1 1) means only Yiddish Digraphs (0x5f0-0x5f2) are present, no add'l punctuation
        # : 8 (1 0 0 0) means only additional punctuation (0x5f3-0x5f4) is present
        # : 0 (0 0 0 0) means neither of the above is present
        # : f (1 1 1 1) means both Yiddish Digraphs as well as additional punctuation is present.
        Lang="Hebrew";
        # From the Jewish 'Shema Yisrael' 'אֶחָד' Prayer: "May his name be blessed forever and ever."
        # Sample="מי ייתן שם להתברך לנצח נצחים שלו."   # With no markings
        Sample="בָּרוּךְ שֵׁם כְּבוֹד מַלְכוּתוֹ לְעוֹלָם וָעֶד."      # RTL Words are reversed when $assigned
        # Note: If the words are reversed here, they appear in the proper order on the screen and in
        #       the .fodt file, but the characters within each word are in reverse order. Because some
        #       characters are altered due to their display order, things can get really bizzare. Sigh!
        LangCode='he'                                           # Hebrew (ISO 639-1)
        LangCode='he'                                           # Hebrew (ISO 639-1)
        # Languages spoken in Israel: ar-IL (Arabic) en-IL (English) he (Hebrew) yi (Yiddish)
        ScriptTag="hebr"
        # Hebr/125: Hebrew Script Unicode blocks: 0x0590-0x05ff; 0xfb00-0xfb4f (Presentation forms)
        # 0591-05af (Cantillation Marks); 05b0-05c7 (Points and Punctuation));
        # 05d0-05ea (Actual alphabet) 05f0-05f4 (Yiddish digraphs q.v. and additional punctuation)
     ;;
"CYRI" ) HexCode="0x0411 0x0414 0x042f 0x0496"                                    # 258/83/83/64/83
        # Here, this essentially means "Russian" (which points to this case anyway); see note.
        TestChar="Б Д Я Җ"                                      # N.B. MUST USE NON-BREAKING SPACES!
        CharMap="0004:[[:space:]]ffff[[:space:]01-9a-f]\{5\}ffffffff[[:space:]01-9a-f]\{5\}ffff"
        # Note: Here I'm only looking for the basic Russian alphabetic characters. The "anything{5}"
        #       gaps eliminate checking for some Cyrillic extensions in the ranges from 0x0400-0x040f
        #       and 0x0450-0x045f (and, of course, beyond); if you care about these $CharMap will
        #       need to be modified accordingly.
        Lang="Cyrillic"
        LangCode='ru'                                           # Russian (ISO 639-1)
        # Note that "Cyrillic" is a script, not a language; here I am treating it as if it refers to
        #      the Russian language; for my own use, that makes things easier, but beware!!!
        # Other languages that use Cyrillic script:
        # az-Cyrl (Azerbaijani), ru-RU (Russian), sr-Cyrl (Serbian), uz-Cyrl (Uzbek)
        # Note that Serbian, for example, uses different glyphs for some of its characters - one reason
        #      this routine is not meant for "production" use.
        ScriptTag="cyrl"
        Sample="Доброе утро"                                    # "Good Morning"
        # Cyrillic Script Unicode block: 0x0400-0x04ff
     ;;
"DEVA" ) HexCode="0x0919 0x0921 0x0935";                                              # 258/4/4/4/4
        # Here, this essentially means "Hindi" (which points to this case anyway); see note.
        TestChar="ङ ड व"                                        # N.B. MUST USE NON-BREAKING SPACES!
        CharMap="0009:[[:space:]01-9a-f]\{8\}"
        # Note:
        Lang="Devanagari"
        LangCode='hi'                                           # Hindi (ISO 639-1)
        # See the first note in the "CYRL" case; this is for my own convenience.
        # SOME other (of >120) languages that use Devanagari script:
        # kok (Konkani), mr (Marathi), ne (Nepali), pi (Pali), sd-IN (Sindhi) and, of course,
        # sa (classical Sanskrit)
        ScriptTag="deva"
        Sample="मेरे नमूना स्क्रिप्ट हिंदी में लिखा है"                     # "My sample script (is) written in Hindi"
        # The Sample text is displayed correctly in the fodt output, but letters are not joined together
        # properly on the terminal display.
        # The # marking the comment is at character position 83, whereas in most other lines it is at
        # position 69; this is because the character count of the sample is higher than it appears due
        # to the glyph composition that takes place with this particular Hindi sequence.
        # Bash decomposes this into individual glyphs on my terminal screen, but the output is rendered
        # correctly on the .fodt output, or when copied 'as is' from the terminal to LibreOffice Writer
        # and other applications. I originally thought that was because none of the mono-spaced terminal
        # fonts on my system report support for ISO 15924 script 'deva' or for the ISO 639-1 language
        # code 'hi' (which none of them do). I later became convinced it may be because of the terminal
        # itself; if I set the terminal profile to use FreeSerif (a proportional spaced font that does
        # report the 15924 and 639-1 codes correctly, the decomposition persists. It is also evident
        # that the terminal in this case forces the variable width glyphs of FreeSerif into mono-spaced
        # cells (and looks awful in the process as would be expected). Compare this to Thai below.
        # Deva/317: Devanagari Script: Unicode blocks: 0x0900-0x097f; Extended block is 0xa8e0-0xa8ff
     ;;
"GREE" ) HexCode="0x1f00 0x1f01 0x1f0f 0x1fa0 0x1fa1 0x1faf"    #                       # 258/66/66/58/66
        TestChar="ἀ ἁ Ἇ ᾠ ᾡ ᾯ"                                  # N.B. MUST USE NON-BREAKING SPACES!
        # All of the letters in the standard Greek Alphabet - even many that are identical to Latin
        #     characters, e.g. B, H, K, O, P, and Y - are used in Mathematics, so simply looking for
        #     a selection of Greek alphabetic characters won't really indicate support for the Greek
        #     language. When looking at my own font collection I found 66 fonts that contained all of
        #     the needed composite characters. All of them did contain the 'el' language code, but only
```

```
        #     58 of them had the 'grek' Script Tag. Hence, the use of Greek composite characters here.
        # The $CharMap below doesn't test for ALL extended Greek characters, but is sufficient...
        CharMap="001f:[[:space:]]3f3ffff[[:space:]01-9a-f]\{30\}ffff"    # incl: 1f00-1f15 and 1fa0-1fb3
        Lang="Greek"
        LangCode='el'                                         # Greek (`Ellenic) (ISO 639-1)
        # fc-match uses only 'el', but there are el-CY (Cyprus) and el-GR (Greece) codes as well.
        # Grek/200: Greek Script Unicode block: 0x0370-0x03ff
        #         Greek Extended Unicode block: 0x1f00-0x1fff  # MORE IMPORTANT FOR ACTUAL GREEK
        ScriptTag="grek"
        Sample="Καλημέρα, είπε ο Αριστοφάνης με Βάτραχοι του"  # "Good Morning, said Ar... to his Frogs"
     ;;
"HEBR" ) HexCode="0x05d0 0x05d3 0x05d8 0x05dd 0x05e9"                              # 258/34/32/22/34
        # Hebrew Script is used not only for modern and biblical Hebrew, but also for Yiddish, an
        #        entirely different spoken language (though mostly spoken by Jewish Europeans); to
        #        illustrate handling alternate languages using the same script, see YIDD below.
        # The phrase "Hebrew Language" is written as "vapv vgfsh," using Hebrew lyx IME keyboard layout.
        # Note that the order of these characters is reversed from that of the Hex Codes: Hebrew is RTL!
        # On the screen output, they will be listed left-to-right however. (it's a bash thing)
        # This CharMap pattern finds ONLY THE BASIC Hebrew Alphabet (0x05d0-0x05ea) # See other CharMaps
        TestChar="א ד ט ם ש";                                 # N.B. MUST USE NON-BREAKING SPACES!
                                                              # RTL Chars are reversed when $assigned
        CharMap="0005:[[:space:]01-9a-f]\{55\}ffff[[:space:]01-9a-f]\{10\}7ff"
        Lang="Hebrew";
        Sample="בוקר טוב";                                    # "Good Morning" ('cues yuc' using IME)
     #  Sample="בוקד טוב";                                    # "Good Morning" with RTL & LTR Codes
                                                              # RTL Words are reversed when $assigned
        LangCode='he'                                         # Hebrew (ISO 639-1)
        # Languages spoken in Israel: ar-IL (Arabic) en-IL (English) he (Hebrew) yi (Yiddish)
        ScriptTag="hebr"
        # Hebr/125: Hebrew Script Unicode blocks: 0x0590-0x05ff; 0xfb00-0xfb4f (Presentation forms)
        # 0591-05af (Cantillation Marks); 05b0-05c7 (Points and Punctuation));
        # 05d0-05ea (Actual alphabet) 05f0-05f4 (Yiddish digraphs q.v. and additional punctuation)
     ;;
"KORE" ) HexCode="0x3148 0x3155 0x3139 0xae4f 0xbaa8"          # 3 Jamo and 2 Hangul
        TestChar="ㅈ ㅕ ㄹ 깏 모";                              # N.B. MUST USE NON-BREAKING SPACES!
        CM="[[:space:]]f\{8\}"
        CharMap="00ac:$CM$CM$CM$CM$CM$CM$CM$CM"
        # CharMap="00ac:[[:space:]]ffffffff[[:space:]]ffffffff[[:space:]]ffffffff"
        Lang="Korean";                                        # Non-standard name for output here
        LangCode='ko'                                         # Koreanic 한국어 (ISO 639-1)
        ScriptTag="hang"
        Sample="이것은 한국어 텍스트입니다."                       # Only used for fodt generation
        # Hangul Syllables Plane: 0xac00-0xd7af
     ;;
"LAOO" ) HexCode="0x0eae 0x0ec3 0x0ed5";                                          # 258/9/9/9/9
        TestChar="ຮ ໃ ໕";                                     # N.B. MUST USE NON-BREAKING SPACES!
        CharMap="000e:[[:space:]01-9a-f]\{37\}fef02596[[:space:]]3bffecae[[:space:]]33ff3f5f"
        # CharMap is '000e:'37x(spaces, 0s or 1s), then pattern (including required spaces
        Lang="Laotian";
        LangCode='lo'                                         # Lao (ISO 639-1)
        ScriptTag="lao"                                       # Strictly speaking, this is "lao "
        Sample="ທ່ານສາມາດເວົ້າພາສາລາວ?";      #
        # Laoo/356: Lao Script Unicode block: 0x0e81-0x0eff (sparse block as shown below)
        # e81-e82 e84 e87-e88 e8a e8d e94-e97 e99-e9f ea1-ea3 ea5 ea7 eaa-eab ead-eb9 ebb-ebd ec0-ec4
        # ec6 ec8-ecd ed0-ed9 edc-edd:  ede (Khmu Gaw) and edf Khmu Nyaw) exist but are seldom used.
     ;;
"PERS" ) HexCode="0x06af 0x0698 0x0686 0x067e"                                    # 258/18/16/18/18
        TestChar="گ ژ چ پ"                                    # N.B. MUST USE NON-BREAKING SPACES!
        # The following pattern, like that used for Arabic above, looks only for the basic (ISO 8859-6)
        # Arabic alphabet (qv), but adds 4 characters that appear only in Persian to narrow the search.
        CharMap="0006:[[:space:]01-9a-f]\{11\}[7f][f]\{5\}[ef]"
        CharMap=$CharMap"[[:space:]01-9a-f]\{10\}[4-7c-f]"     # concatenate Persian-only char 0x067e
        CharMap=$CharMap"[[:space:]01-9a-f]\{9\}[13579bdf]"    # concatenate Persian-only char 0x0698
        CharMap=$CharMap"[01-9a-f]\{4\}[4-7c-f]"               # concatenate Persian-only char 0x0686
        CharMap=$CharMap"[[:space:]01-9a-f]\{6\}[8-f]"         # concatenate Persian-only char 0x06af
        Lang="Persian"                                        # aka known informally as Farsi
        LangCode="fa"                                         # fa-IR (IR for Iranian Farsi)
        ScriptTag="arab"                                      # Uses Arabic script and
        Sample="اسکریپت نمونه من این است که به زبان فارسی نوشته" # "My sampl scrpt is writtn in Persian"
        # * Persian has four letters more than the Arabic alphabet: ژ, چ, پ, and گ.
        # Arab/160: Arabic Script Unicode blocks: 0x0600-; 0x0750-; 0x08a0-; 0xfb50-; 0xfe70-
     ;;
"THAI" ) HexCode="0x0e01 0x0e09 0x0e14 0x0e42 0x0e55";                            # 258/65/62/65/65
        TestChar="ก ฉ ด โ ๕";                                 # N.B. MUST USE NON-BREAKING SPACES!
        CharMap="000e:[[:space:]]fffffffe[[:space:]]87ffffff[[:space:]]0fffffff"
        Lang="Thai";
        LangCode='th'                                         # Thai (ISO 639-1)
        # Thai/352: Thai Script Unicode block: 0x0e01-0x0e7f
        ScriptTag="thai"
```

```
        Sample="แฟรงค์โอเบอลีทำนี้ บิ่ ปิ่ ญู ญู";                # the final 4 check for glyph arrangement
        # The # marking the comment is at character position 78, whereas in most other lines it is at
        # position 69; this is because the character count of the sample is higher than it appears due
        # to the multi-glyph compositions that take place with this particular Thai sequence. Unlike
        # Hindi however (see above), this sample displays correctly on the terminal (as well as on the
        # various outputs) because all of the Thai vowels and tone marks used are "dead keys."
     ;;
"YIDD" ) HexCode="0x05d0 0x05d3 0x05d8 0x05f0 0x05f1"                               # 258/34/32/22/34
        TestChar="א ד ט װ ױ";                                    # N.B. MUST USE NON-BREAKING SPACES!
        # Substituted 2 Yidish-only digraphs in the hex codes, but these are not displayed here.
        # The Yiddish Language is spoken in Israel and various European countries. For its alphabet
        # it uses Hebrew Script, but with the addition of specific Yiddish Digraphs (0x05f0-0x05f2).
        # Digraphs are two glyphs which remain separate glyphs, but are placed very close together.
        # Note that the order of these characters is reversed from that of the Hex: Yiddish is also RTL!
        # On the screen output, they will be listed left-to-right however (it's a bash thing)
        CharMap="0005:[[:space:]01-9a-f]\{55\}ffff[[:space:]01-9a-f]\{10\}7ff"              # 32/34/258
        # Regarding the [078f] portion of the pattern above: in addition to the alphabet, a value of:
        # : 7 (0 1 1 1) means only Yiddish Digraphs (0x5f0-0x5f2) are present, no add'l punctuation
        # : 8 (1 0 0 0) means only additional punctuation (0x5f3-0x5f4) is present
        # : 0 (0 0 0 0) means neither of the above is present
        # : f (1 1 1 1) means both Yiddish Digraphs as well as additional punctuation is present.
        Lang="Yiddish";
        # Yiddish "looks like Hebrew but doesn't sound like Hebrew" (Translation of $Sample below).
        Sample="קוקט ווי העברעיש אָבער טוט נישט געזונט ווי העברעיש"
        LangCode='yi'                                            # Yiddish (ISO 639-1)
        ScriptTag="hebr"
        # Hebr/125: Hebrew Script Unicode blocks: 0x0590-0x05ff; 0xfb00-0xfb4f (Presentation forms)
        # 05d0-05ea (Actual alphabet) 05f0-05f4 (Yiddish digraphs and additional punctuation)
     ;;
# The Keywords below don't represent any "official" category, but are merely things I've looked for:
"BOXD" ) HexCode="0x250c 0x2500 0x2518"                                             # 258/94/_/_/91
        TestChar="┌ ─ ┘"                                         # N.B. MUST USE NON-BREAKING SPACES!
        CharMap="0025:[[:space:]01-9a-f]\{8\}"                   # TO DO: Incomplete: NEEDS FIXING
        Lang="Box Drawing"                                       # Non-standard name for output here
        LangCode='99'                                            # Language not relevant
        Sample="╓──┬──╖ ┌───┘";
        # Box Drawing Script Unicode block: 0x2500-0x257F
     ;;
"CURR" ) HexCode="0x20ac 0x20ad 0x20b9 0x20aa 0x20a9"                               # 258/42/_/_/42
        # The currncy symbols in the lines above and below are: Euro, Kip, Rupee, Shekel, Yen, Won
        TestChar="€ ₭ ₹ ₪ ₩";                                    # N.B. £ (0xa3) and ¥ (0xa5) are "Latin"
        # Currency Plane occupies right half of word 5 and left half of word 6 in the 0020: row
        CharMap="0020:[[:space:]01-9a-f]\{50\}[[:space:]01-9a-f]\{9\}"  # Could permit all 0s: FIX THIS!
           # "0020: fffffff fffffcff fffffff fff3001f 001f7fff 03ffffff ffff0000 0001ffff"
           #  echo ${CMap:46:9} pulls out relevant part:    7fff 03ff
           #  These characters cannot ALL be 0 !!   # But this will do for the moment
        Lang="Currency";                                         # Non-standard name for output here
        LangCode='99'                                            # Used universally; language not relevant
        Sample="\$5 = ₩5,682.98 = €4.59 = ₪19.31 = 158,435﷼ etc."; # Note: "$" must be escaped in bash!
        # Currency Symbols Unicode block: 20a0-20cf; also in a variety of other scripts
        # http://www.xe.com/symbols.php and https://gist.github.com/bzerangue/5484121 shows collections.
        # 0x20a1 (₡ Costa Rica Colon), 0x20ac (€ {various} Euro), 0x00a3 (£ {various} Pound),
        # 0xfdfc (﷼ Iranian Real),    0x20aa (₪ Israeli Shekel), 0x00a5 (¥ Japanese Yen),
        # 0x20a9 (₩ Korean Won),       0x20ad (₭ Laotian Kip),    0x20b1 (₱ Philippine Peso),
        # 0x0e3f (฿ Thai Baht),        0x20b9 (₹ Indian Rupee - also see devanagari letter U+0930)
     ;;
"DOMI" ) HexCode="0x1f053";                                      # Merely an example of Unicode values
        TestChar="🁓";                                          #   higher than 0xffff; see "MUSI" below
        CharMap="01f0:[[:space:]01-9a-f]\{8\}"                   #   for comments about that range.  258/0
        Lang="Dominoes";                                         # Non-standard name for output here
        LangCode='99'                                            # Language not relevant
        Sample="🁓🁓🁓";                                         # Only used for fodt generation
        # Domino Tiles Unicode block: 0x1f030-0x1f09f;  1f030-1f093 are used
     ;;
"FRAC" ) HexCode="0x00bc 0x00bd 0x00be"                                             # 258/215/_/_/215
        TestChar="¼ ½ ¾"                                         # N.B. MUST USE NON-BREAKING SPACES!
        CharMap="0000:[[:space:]01-9a-f]\{46\}[01-9a-f]"         # ANY, not all of the above 3 fractions
        Lang="Ligatures";                                        # Non-standard name for output here
        LangCode='99'                                            # Language not relevant
        Sample="One-quarter is ¼; one half is ½; three-quarters is ¾."
     ;;
"LIGA" ) HexCode="0xfb00 0xfb01 0xfb02 0xfb03 0xfb04 0xfb05 0xfb06"                # 258/20/_/_/20
        # Characters above and below are cherry-picked from the 0xfb00-0xfb4f Block
        TestChar="ﬀ ﬁ ﬂ ﬃ ﬄ ﬅ ﬆ"                                # N.B. MUST USE NON-BREAKING SPACES!
        CharMap="00fb:[[:space:]01-9a-f]\{7\}7f"                 # 20/258        # 0xfb00-0xfb4f Block
        # ALTERNATE GROUPINGS OF LIGATURES for when you just need to feel depressed ...
    #   HexCode="0x0c6"                                                               # 258/3/_/_/3
    #   TestChar="Æ";                                             # N.B. MUST USE NON-BREAKING SPACES!
    #   CharMap="0000:" # [[:space:]01-9a-f]\{7\}" # 7f"          # 0/3/258
  #      HexCode="0x0e6"                                                              # 258/10/_/_/10
```

```
       #      TestChar="æ";                                            # N.B. MUST USE NON-BREAKING SPACES!
       #      CharMap="0000:" # [[:space:]01-9a-f]\{7\}" # 7f"         # 2/10/258
     #        HexCode="0x152 0x153"                                                                  # 258/9/_/_/9
     #        TestChar="Œ œ";                                          # N.B. MUST USE NON-BREAKING SPACES!
     #        CharMap="0015:" # [[:space:]01-9a-f]\{7\}" # 7f"         # 9/258
             Lang="Ligatures";                                        # Non-standard name for output here
             LangCode='99'                                            # Language not relevant
             Sample="effective or eﬀective: eﬃciency or efficiency: ﬅupendous or stupendous";
             # Alphabetic Presentation Forms Unicode block: 0xfb00-0xfb4f
             # See: https://en.wikipedia.org/wiki/List_of_precomposed_Latin_characters_in_Unicode
             # C1 Controls and Latin-1 Supplement Unicode block: 0080-00ff! Not recommended by Unicode but...
             # Latin Ligatures, like a few other natural groupings, are scattered all over the place, so:
             # TO DO: CAN MULTIPLE HEX CODE GROUPS (0080 & fb00) BE SENT BELOW? NEED TO CHECK WHAT I DID...
          ;;
    "MUSI" ) # HexCode="0x1d106 1d10b 0x1d120 0x1d160";               # REPLACED: See next assignment line.
"            # TestChar="𝄆 𝄋 𝄞 ♪"
             # The "official"* Musical Symbols Unicode block is nominally 0x1d100-1d1ff, with the segments
             #     1d100-1d126, 1d129-1d158, 1d15a-1d172, and 1d17b-1d1e8 being the actual characters
             #     * The "official" version was introduced in version 3.1 of Unicode (March 2001)
             # These characters are all present in both .ttf and .otf versions of FreeMono for example but,
             #     as with other scripts that begin beyond 0xffff, they are not reported by ttfdump or any
             #     other font utility I've been able to locate.
             # MuseScore, for example, uses their own MScore font, which has glyphs in a private use segment
             #     (e.g. 0xe19b) but that's not generally usable due to the proprietary encoding.
             # Therefore: use the limited set of Musical Symbols located in the Unicode Miscellaneous Symbols
             #     block that runs from 0x2600-0x26ff; the following are the applicable symbols for music.
             HexCode="0x2669 0x266a 0x266b 0x266c 0x266d 0x266e 0x266f"                          # 258/34/_/1/34
             #   ♩ 2669 quarter note            ♪ 266A eighth note       ♫ 266B beamed eighth notes
             #   ♬ 266C beamed sixteenth notes   ♭ 266D music flat sign    ♮ 266E music natural sign
             #   ♯ 266F music sharp sign
             TestChar="♩ ♪ ♫ ♬ ♭ ♮ ♯";                                # TestChar="𝄆 𝄋 𝄞 ♪"; # TestChar="   ";
             CharMap="0026:[[:space:]01-9a-f]\{8\}"                   # Was: ="01d1:[[:space:]01-9a-f]\{8\}"
             Lang="Music";                                            # Non-standard name for output here
             LangCode='99'                                            # Language not relevant
             ScriptTag="musc"
"            Sample="𝄠♯𝅗𝅥𝅘𝅥𝅘𝅥𝅮𝅘𝅥𝅮𝅘𝅥𝅯"                                      # Only used for fodt generation
          ;;
         * ) HexCode="0x0041 0x0042 0x0079 0x007a";
             TestChar="A B y z";                                      # N.B. MUST USE NON-BREAKING SPACES!
             CharMap="0000:[[:space:]01-9a-f]\{8\}"
             Lang="English";
             LangCode='en'                                            # English (ISO 639-1)
             Sample="Good Morning";
             # C0 controls and Basic Latin Unicode block: 0x0000-0x007f (formerly called lower ASCII)
          ;;
    esac
    # Note that all variable definitions are GLOBAL (the default in Bash), so any caller has easy access.
  }

### MAIN SCRIPT DEFINITION ROUTINE: Interprets parameters passed to this shell script, and calls the
# convertKeyWord() function to grab several values for each Script/Language we are interested in looking at.
# Here we define the particular scripts we are interested in; one to $NumArgsAccepted may be specified as
# command line parameters, but if none are given explicitly, we'll look for fonts containing Thai characters.
echo $MajorSeparator
if [ $# == 0 ]; then                                                  # If TRUE could just show usage and exit
  # The default to Thai is for my own convenience; as currently written, up to $NumArgsAccepted parameters
  # can be given from the following supported (and case-insensitive) entries:
  #    Arab[ic],  Arme[nian],  Bibl[ical (Hebrew)], Cyri[llic],  Deva[nagari], Fars[i],     Gree[k],
  #    Hebr[ew],  Kore(an),    Hind[i],             Iran[ian],   Laot[ian],    Pers[ian],   Russ[ian], Thai,
  #    Yidd[ish], Box Drawing, Curr[ency],          Domi[noes],  Frac[tions],  Liga[tures], Musi[c]
  # Otherwise, for any unrecognized keyword, this will search for fonts containing Latin characters
  echo "INFO: No command line parameters given; we're looking for Thai characters by default"
  Keyword="THAI"
  convertKeyWord $Keyword                                             # Grab specific values for this language
  TestCodeList=$HexCode; LangCodeList=$LangCode; CMapList=$CharMap
  SampleText=$Sample                                                  # This reverses word order in RTL phrases
  Message=$TestChar' ('$HexCode')'
  CharMsg="'"$TestChar"'"
  LangList[1]=$Keyword
  LangAbbrevList[1]=$LangCode
  OTFCapList=$ScriptTag
else
  for arg in `seq 1 $NumArgsAccepted`; do                             # Wander through each argument passed in
    if [ ${!arg} ]; then                                              # If any "arg"th argument was passed
      Keyword=$(echo ${!arg} |cut -c1-4 |tr '[:lower:]' '[:upper:]')  # Create 4 char upper case keyword
      # Unicode planes contain SCRIPTS, although any Script may be used by multiple languages.
      # These "translations" convert languages I commonly refer to into the Scripts they use.
      # This is NOT scalable, as some languages can be written in more than one script!
      #    For example: Azerbaijani, Japanese, Kyrgyzstani, Moldovan, Mongolian, and Turkmenistani: Beware!
      #    Inuktitut can be written in its own syllabary, a modified Cherokee alphabet or with Latin letters.
```

```
      if [ $Keyword == "HIND" ]; then Keyword="DEVA"; fi            # Convert Language to required Script
      if [ $Keyword == "RUSS" ]; then Keyword="CYRI"; fi            # Convert Language to required Script
      if [ $Keyword == "FARS" ]; then Keyword="PERS"; fi            # Make Farsi an alias for Persian
      if [ $Keyword == "IRAN" ]; then Keyword="PERS"; fi            # Make Iranian an alias for Persian
      if [ $Keyword == "MESR" ]; then Keyword="ARME"; fi            # Make Armenian an alias for Mesropian
      if [ $Keyword == "LAOT" ]; then Keyword="LAOO"; fi            # Compensate for odd abbreviation
      convertKeyWord $Keyword                                       # Create variables for this argument
      TestCodeList=$TestCodeList" "$HexCode; LangCodeList=$LangCodeList" "$LangCode   # Expand lists
      CMapList=$CMapList" "$CharMap;         SampleText=$SampleText" "$Sample         # Expand lists
      ((ArgsFound++))
      if [ $ArgsFound == $# ] && [ $# != 1 ]; then                  #
        Message=$Message' and '$TestChar' ('$HexCode')'             # Need "and" for last entry but not first
        CharMsg=$CharMsg' and '"'"$TestChar"'"
      else
        Message=$Message' '$TestChar' ('$HexCode')'                 # Otherwise just separate with spaces
        CharMsg=$CharMsg' '"'"$TestChar"'"
      fi
      # In either case above, $Message has the embedded RTL Characters from $TestChar in a reversed order
      # I suspect this is a side effect of font rendering mechanisms interpreting spaces as "Latin"
      LangList[arg]=$Keyword
      LangAbbrevList[arg]=$LangCode
      OTFCapList=$OTFCapList" "$ScriptTag
    fi
  done                                                              # Done: for arg in `seq 1 $NumArgsAcce...
fi                                                                  # Done: if [ $# == 0 ]

### OPEN AN .fodt FILE (if the FODTGen flag is set) and create the initial part of the header
# Now we prepare to create a demonstration document that can be loaded into LibreOffice Writer or other
# application that can read .fodt files (bare xml versions of .odt files). We need to establish a full
# path name for the file, because we will be in different directories as we write to it, which can get ugly.
# TO DO: Include Font style information when creating the .fodt output ::: gave up; not recognized by LO
if [ $FODTGen == 1 ]; then
  DemoDoc=$Origin"/"$FODTDOC".fodt"
  # Experimental stuff: See /mnt/Library/Ubuntu/Unity_Screen_Elements.fodt for things to rip off...
  echo '<?xml version="1.0" encoding="UTF-8"?>' > $DemoDoc            # CREATE NEW FILE; then append below
  echo ''                                                                                   >> $DemoDoc
  echo '<office:document'                                                                   >> $DemoDoc
  echo ' xmlns:office="urn:oasis:names:tc:opendocument:xmlns:office:1.0"'                   >> $DemoDoc
  echo ' xmlns:style="urn:oasis:names:tc:opendocument:xmlns:style:1.0"'                     >> $DemoDoc
  echo ' xmlns:text="urn:oasis:names:tc:opendocument:xmlns:text:1.0"'                       >> $DemoDoc
  echo ' xmlns:table="urn:oasis:names:tc:opendocument:xmlns:table:1.0"'                     >> $DemoDoc
  echo ' xmlns:fo="urn:oasis:names:tc:opendocument:xmlns:xsl-fo-compatible:1.0"'            >> $DemoDoc
  echo ' xmlns:meta="urn:oasis:names:tc:opendocument:xmlns:meta:1.0"'                       >> $DemoDoc
  echo ' xmlns:number="urn:oasis:names:tc:opendocument:xmlns:datastyle:1.0"'                >> $DemoDoc
  echo ' xmlns:script="urn:oasis:names:tc:opendocument:xmlns:script:1.0"'                   >> $DemoDoc
  echo ' xmlns:loext="urn:org:documentfoundation:names:experimental:office:xmlns:loext:1.0"'    >> $DemoDoc
  echo ' xmlns:field="urn:openoffice:names:experimental:ooo-ms-interop:xmlns:field:1.0"'    >> $DemoDoc
  echo ' xmlns:formx="urn:openoffice:names:experimental:ooxml-odf-interop:xmlns:form:1.0"'  >> $DemoDoc
  echo ' xmlns:css3t="http://www.w3.org/TR/css3-text/"'                                     >> $DemoDoc
  echo ' office:version="1.2"'                                                              >> $DemoDoc
  echo ' office:mimetype="application/vnd.oasis.opendocument.text">'                        >> $DemoDoc
  echo ' <office:styles>'                                                                   >> $DemoDoc
  echo ' </office:styles>'                                                                  >> $DemoDoc
  echo ' <office:body>'                                                                     >> $DemoDoc
  echo '  <office:text>'                                                                    >> $DemoDoc
  echo '   <text:p >Font Samples for selected fonts:</text:p>'                              >> $DemoDoc
  echo '   <text:p >This file is '$DemoDoc'</text:p>'                                       >> $DemoDoc
  echo '   <text:p/>'                                                                       >> $DemoDoc
  echo '   <text:p >Thai Script Sample: นี้ถูกเขียนโดยแฟรงค์โอเบอลี</text:p>'                          >> $DemoDoc
  echo '   <text:p >Devanagari Script Sample: यह अंग्रेजी भाषा नहीं है (Hindi Language)</text:p>'      >> $DemoDoc
  echo '   <text:p >Hebrew Script Sample: זו השפה העברית; N.B. Hebrew is right to left</text:p>' >> $DemoDoc
  echo '   <text:p/>'                                                                       >> $DemoDoc
  echo '   <text:p/>'                                                                       >> $DemoDoc
           # $Message below looks strange in the .fodt file if it contains an RTL character
           # but it is read and displayed correctly by LibreOffice Writer
  echo '   <text:p >The following is a list of fonts in the directories:</text:p>'          >> $DemoDoc
  echo '   <text:p >    '$Where2Look'</text:p>'                                             >> $DemoDoc
  echo '   <text:p >that contain the character(s) '$Message'</text:p>'                      >> $DemoDoc
  echo '   <text:p/>'                                                                       >> $DemoDoc
fi                                                                  # Done (momentarily): if [ $FODTGen ==...

# Generate a list of 'suspicious' fonts, i.e. those that may require replacement
if [ $SuspectGen == 1 ]; then                                       # Switch set at beginning of this script
  SFLFN=$Origin"/"$SFLFN
  printf "This file is: $SFLFN\n"                                                            > $SFLFN
  printf "This lists Font Files that may need repair or replacement due possible errors.\n"     >> $SFLFN
  printf "Note: When examining multiple Scripts/Languages, not all suspect fonts may appear.\n"  >> $SFLFN
  printf "$MiniSeparator\n\n"                                                                >> $SFLFN
  printf "The following directory tree(s) were examined: $Where2Look\n\n"                    >> $SFLFN
fi                                                                  # Done: if [ $SuspectGen == 1 ]
```

```
inspectFont()                                 # Lists info about each font containing the specified HexCode(s)
  {
   ((FontsChecked++))                                                 # Increment number of fonts examined
   FullMatchFlag=1   # Assume a full match until proven otherwise
   #### This section looks in each font for one or more specific characters from a particular script:
   CSetMatch=$(fc-match $Location/$DirName$fontf charset)
   for HexCode2Find in $TestCodeList; do                              # Examine each hex code group in turn
     for OneCode in $HexCode2Find; do                                 # Check each hex code in $TestCodeList
       if [ $debug == 'ON' ]; then printf "%40s" "Checking $OneCode in $fontf: "; fi
       # Use ttfdump to find out if this font contains the hex code sequences we're currently looking for.
       # SymLinks cause errors here, so send them to the bit bucket: I'm too lazy to extract all link info
       #    since only one link was installed by my OS as a fallback for Japanese, which I don't use. YMMV
       if TmpOut=$(ttfdump -t cmap $Location/$DirName$fontf 2>/dev/null | grep $HexCode2Find); then
         Success="Yes"                                                # Success contingent on entire loop
                                                   if [ $debug == 'ON' ]; then echo $OneCode " found ..."; fi
       else
         Success="No"                                                 # Any "No" causes a failure for this font
                        if [ $debug == 'ON' ]; then echo $OneCode " NOT found: skipping to next font ..."; fi
         break 2                                                      # If ANY Code not found, exit both
       fi                                                             # Done: if TmpOut=$(ttfdump -t cmap ...
     done                                                             # Done: for OneCode in $HexCode2Find
   done                                                               # Done: for HexCode2Find in $TestCodeList
   if [ "$Success" = "Yes" ]; then                                    # If ALL HexCodes in TestCodeList found
     ((FontsMatched++))                                               # Increment Num of fonts w/all hex codes
     printf "$Fmt" $fontf "( located in:" $Location/$DirName" )"
     printf "%38s %s\n" " " "Potential match $FontsMatched of $FontsChecked Fonts checked so far... "
         # The echo below is used as an intermediary to remove leading spaces from fc-query output line
         FntSty=$(echo $(fc-query "$Location/$DirName$fontf" |  \
                                   grep "style"                |  \
                                   sed s/"style:"//            |  \
                                   sed s/"stylelang*"//)       |  \
                                   cut -c 1-72)                       # Trim the output for screen display
         FntSlt=$(fc-query "$Location/$DirName$fontf" | grep "slant"  | sed s/"slant:"//)  #
         FntWgt=$(fc-query "$Location/$DirName$fontf" | grep "weight" | sed s/"weight:"//) #
         FntWid=$(fc-query "$Location/$DirName$fontf" | grep "width"  | sed s/"width:"//)  #
     printf "%36s %s\n" " " "  Font Style begins: $FntSty"
     FntSltWgtWid=$(echo $FntSlt","$FntWgt", and"$FntWid);
     printf "%36s %36s %6s, %8s and %8s\n" " " "  Font Slant, Weight, and Width are:" \
                                                   $FntSlt $FntWgt $FntWid

     if [ $FODTGen == 1 ]; then                                       # If an .fodt file was requested
       writeSample "$fontf contains the requested character(s) ..."   \
                   "$fontf is located in: $Location/$DirName"         \
                   "Font Slant, Weight, and Width are: $FntSltWgtWid" \
                   "$SampleText"                                      # Report this font in the output fodt
     fi                                                               # Done:if [ $FODTGen == 1 ]

     #### Now check the Language Support reported by this font to see if it's correct
     LangIdx=0                                                        # Language Code: Index for array
     for OneCode in $LangCodeList; do                                 # Check each language to be reported
       ((LangIdx++))                                                  # Increment lang code index
       PLFSwitch=0                                                    # PerLangFoundSwitch limits to 1 match
       if TmpOut=$(fc-query "$Location/$DirName$fontf" | grep "|$OneCode|") # Does fc-match find OneCode
       then
         printf "$Fmt" " " "√ fc-query correctly reports the ISO 639-1 Language Code: '$OneCode'"
         if [ $PLFSwitch == 0 ]; then                                 # So we don't double count errors
           ((LangsMatched[LangIdx]++))
           printf "$Fmt" " " \
                  "  ...match number ${LangsMatched[LangIdx]} for the ISO 639-1 Language Code '$OneCode'"
           ((PLFSwitch++))                                            # Could just be set to 1
         fi
       else
         # Don't print a negative result if this is a fake language (e.g. currency, music symbols, etc.)
         if [ $OneCode != '99' ]; then
            # echo -en $ErrColor # This works stand-alone but not in script, and it doesn't work with printf
            # ErrColor='\e[1;41;37m' #(Red on White) # # NmlColor='\e[27m'  # echo -en $ErrColor
           printf "$Fmt" ">>" "X fc-query FAILED TO REPORT the ISO 639-1 Language Code '$OneCode'"
           FullMatchFlag=0                                            # No Failures will be added to list
                               if [ $debug == 'ON' ]; then echo "FullMatchFlag set back to "$FullMatchFlag; fi
           if [ $SuspectGen == 1 ]; then                              # Switch set at beginning of this script
             printf "For '$OneCode':    $Location/$DirName$fontf "                                  >> $SFLFN
             printf "FAILED TO REPORT this ISO 639-1 Language Code.\n"                              >> $SFLFN
           fi                                                         # Done: if [ $SuspectGen == 1 ]
         else
           printf "$Fmt" "  " "- Code '$OneCode' is not a language, so no language reporting was attempted."
         fi                                                           # Done: if [ $OneCode != '99' ]
         ((LangMatchFailures++))                                      # Increment Num fonts lacking lang code
       fi                                                             # Done: if TmpOut=$(fc-match...
     done                                                             # Done: for OneCode in $LangCodeList
```

```
  #### Check the Open Type Layout capability for this font (can be in both TrueType and OpenType fonts)
  OTCapIdx=0                                                   # OpenType Capabilities: Index for array
  for OneCap in $OTFCapList; do                                # Check OTF capability for each font
    ((OTCapIdx++))
    POCFSwitch=0                                               # PerOtfCapFoundSwitch limits to 1 match
    if TmpOut=$(fc-query "$Location/$DirName$fontf" | grep "capability:\(.*\)otlayout:$OneCap")
    then
      printf "$Fmt" " " "√ fc-query correctly reports ISO 15924 Script Support Code: '$OneCap'"
      if [ $POCFSwitch == 0 ]; then                            # So we don't double count matches
        ((OTFMatches[OTCapIdx]++))
        printf "$Fmt" " " \
               "  ...match number ${OTFMatches[OTCapIdx]} for the ISO 15924 Script Code '$OneCap'"
        ((POCFSwitch++))                                       # Could just be set to 1
      fi
    else
      printf "$Fmt" ">>" "X fc-query FAILED TO REPORT Script Support for ISO 15924 code: '$OneCap'"
      ((OTFMatchFailures[OTCapIdx]++))                         # Increment Num fonts lacking OTF Caps
      if [ $SuspectGen == 1 ]; then                            # Switch set at beginning of this script
        printf "For '$OneCap':  $Location/$DirName$fontf: "                               >> $SFLFN
        printf "Font doesn't report Script Support for this ISO 15924 Code.\n"            >> $SFLFN
      fi                                                       # Done: if [ $SuspectGen == 1 ]
      FullMatchFlag=0                                          # No Failures will be added to list
    fi                                                         # Done: if TmpOut=$(fc-match...
  done                                                         # Done: for OneCap in $OTFCapList

  #### Now check the Character Set Map reported by this font to see if the expected CMap is available
  CMMIdx=0                                                     # Character Map Matches: Index for array
  for CMap in $CMapList; do
    ((CMMIdx++))
    PFCMFSwitch=0                                              # PerFontCMapFoundSwitch is a SWITCH
    Seg=$(echo $CMap | cut -c 1-25)                            # Truncated version for display only
    if CMap=$(fc-query "$Location/$DirName$fontf" | grep "$CMap"); then
      printf "$Fmt" " " \
             "√ fc-query correctly found a Character Map Segment beginning '$Seg'"
      if [ $PFCMFSwitch == 0 ]; then                           # So we don't double count matches
        ((CMapsMatched[CMMIdx]++))                             # Increment number of charsets found
        printf "$Fmt" " " \
               "  ...match number ${CMapsMatched[CMMIdx]} for the Character Set Segment beginning '$Seg'"
        # TO DO (Maybe): HERE we need to update the counter for each char map within the font !!
        ((PFCMFSwitch++))                                      # Could just be set to 1
      fi                                                       # Done: if [ PFCMFSwitch == 0 ]
    else
      #### THIS IS ALL IN FAILURE MODE: LINE CONTAINING CMap couldn't be found; explain what was found
      ((CMapMatchFailures++))                                  # Increment number of charsets NOT found
      FullMatchFlag=0                                          # No Failures will be added to list
      printf "$Fmt" ">>" "X fc-query FAILED TO FIND A CHARACTER MAP SEGMENT DEFINED AS '$Seg'"
      SegHdr=$(echo $Seg | cut -c 1-5)                         # Truncate to just line number requested
      ActualLine=$(echo $(fc-query "$Location/$DirName$fontf" | grep "$SegHdr"))
      # Match failure might be an existing line that doesn't match or no relevant line at all
      if Alternate=$(fc-query "$Location/$DirName$fontf" | grep "$SegHdr"); then
        printf "$Fmt" " " "  ...found: '$ActualLine'"          # Show existing line for comparison
        if [ $SuspectGen == 1 ]; then                          # Switch set at beginning of this script
          printf "For '$SegHdr': $Location/$DirName$fontf: "                             >> $SFLFN
          printf "Font doesn't match the Character Map specified.\n"                     >> $SFLFN
          printf "             Character Map reported was '$ActualLine'.\n"              >> $SFLFN
          printf "             This might be due to one or more missing characters"      >> $SFLFN
          printf " in the font's bitmap.\n"  >> $SFLFN
        fi                                                     # Done: if [ $SuspectGen == 1 ]
      else
        printf "$Fmt" " " "  ...No relevant line for '$SegHdr' was found for this font."
        if [ $SuspectGen == 1 ]; then                          # Switch set at beginning of this script
          printf "For '$SegHdr': $Location/$DirName$fontf: "                             >> $SFLFN
          printf "No relevant line beginning with '$SegHdr' was found.\n"                >> $SFLFN
        fi                                                              # Done: if [ $SuspectGen == 1 ]
      fi                                                       # Done: Alternate=$(fc-query "$Locat...
    fi                                                         # Done: if CMap=$(fc-query "$Locati...
  done                                                         # Done: for CSet in $CMapList; do
  if [ $FullMatchFlag == 1 ]; then                             # Full match flag still ON for this font?
    ((++FullMatchListIdx))
    FullMatchList[FullMatchListIdx]=$Location/$DirName$fontf
    printf "%38s %s\n" " " \
           "Complete Match $FullMatchListIdx of the $FontsMatched potential matches so far... "
  else
                       if [ $debug == 'ON' ]; then echo "No Full Match for "$Location/$DirName$fontf; fi
  fi
  echo $MinorSeparator
else
              if [ $debug == 'ON' ]; then echo $Location/$DirName$fontf": Font Number:" $FontsChecked; fi
fi                                                             # Done: if [ "$Success" = "Yes" ]
```

```
  }                                                                 # Done: inspectFont() function

### MAIN FONT EXAMINATION ROUTINE: Calls inspecFont() to examine each font in each location:
echo -e "Fonts containing the Unicode Character(s):"$CharMsg        # RTL characters are in REVERSE ORDER
echo "..............Looking in directory Trees: "$Where2Look
echo "...........Checking for Language code(s):"$LangCodeList
echo "......Checking for Script Support code(s):"$OTFCapList
echo $MajorSeparator
for Location in $Where2Look                                         # Font directories defined at beginning
do                                                                  # Examine each font directory in turn
  cd $Location                                                      # Switch to next font directory
  # First check any fonts in this parent directory
  fontlist=$(ls -1L | grep -i \.[ot]tf )                            # Create a list of local ttf/TTF files
  # As near as I can tell, all Open Type fonts may be either .ttf or .otf, but not all .ttf files are (or
  # have) Open Type capabilities (e.g. older .ttf fonts). The difference between fonts with Open Type
  # capabilities is that those with a .ttf extension use quadratic Bézier splines curves, and those with an
  # .otf extension use cubic Bézier spline curves (a remnant of the older PostScript Type 1 designs).
  # Beware of .ttf files that report no Open Type capabilities; they may be outdated and need replacement!
  # A collection of TrueType files packaged together has the suffix TTC, but I don't look at them here.
  for fontf in $fontlist; do                                        # Examine each font file in turn
    inspectFont $fontlist
  done                                                              # Done: for fontf in $fontlist
  # Now do all of the above again for each font in each subdirectory (effective limit is 2 levels!)
  DirList=$(ls -d */)                                               # Create a list of subdirectories
  for DirName in $DirList; do                                       # Examine each subdirectory in turn
    fontlist=$(ls -1 $DirName | grep -i \.ttf )                     # Create a list of local ttf/TTF files
    for fontf in $fontlist; do                                      # Examine each font file in turn
      inspectFont $fontlist
    done                                                            # Done: for fontf in $fontlist
  done                                                              # Done: for DirName in $DirList
done                                                                # Done: for Location in $Where2Look

# Begin printing the on-screen summary of the font examination
echo $MajorSeparator
printf "  **************     Examination of $Location directory tree completed.\n"
printf "* Search Result:%5d Truetype/Opentype files were examined for the specified characters.\n"        \
       $FontsChecked
if [ $FODTGen == 1 ]; then                                          # If an .fodt file was requested
  printf "   <text:p >* Search Result:%5d Truetype files were examined, and</text:p>\n"              \
         $FontsChecked                                                                    >> $DemoDoc
fi                                                                  # Done:if [ $FODTGen == 1 ]

# Print results of the character searches in the fonts ...
printf "                 %5d of those files (listed above) contain all the character(s)$CharMsg.\n"        \
       $FontsMatched
echo -e "                        Text Sample(s) for this run: '$SampleText '"    # Incorrectly orders RTL Words
if [ $FODTGen == 1 ]; then                                          # If an .fodt file was requested
  printf "   <text:p >               %5d of those files contain all the character(s)$CharMsg.</text:p>\n" \
         $FontsMatched                                                                    >> $DemoDoc
fi                                                                  # Done:if [ $FODTGen == 1 ]
printf "%21s %s\n" "                 " $MiniSeparator

for LangIdx in `seq 1 $NumArgsAccepted`; do                         # Check Lang for each possible argument
  FinalLangCount=${LangsMatched[$LangIdx]}
  LangCode2=${LangList[$LangIdx]}
  LangAbbrev=${LangAbbrevList[$LangIdx]}
  if [ $LangCode != '99' ]; then                                    # Skip for fake languages (math, etc.)
    if [ $LangMatchFailures != 0 ]; then
      if [ $FinalLangCount != 0 ]; then
        printf "        WARNING:%5d of those $FontsMatched files contained the Language Code '$LangAbbrev'\
 ($LangCode2), BUT $LangMatchFailures FILE(s) DID NOT!\n" ${LangsMatched[$LangIdx]}
        if [ $FODTGen == 1 ]; then                                  # If an .fodt file was requested
          printf "   <text:p >        WARNING:%5d of those $FontsMatched files contained the Language Code '\
$LangAbbrev' ($LangCode2), BUT $LangMatchFailures FILE(s) DID NOT!</text:p>\n" \
             ${LangsMatched[$LangIdx]} >> $DemoDoc
        fi                                                          # Done:if [ $FODTGen == 1 ]
      else
        if [ $LangAbbrev ]; then
          printf "                %5d of those $FontsMatched files contained the Language Code \
'$LangAbbrev' ($LangCode2).\n" ${LangsMatched[$LangIdx]}
          if [ $FODTGen == 1 ]; then                                # If an .fodt file was requested
            printf "%32s %-5s %52s %s\n" "   <text:p >                  "${LangsMatched[$LangIdx]}         \
          " of those $FontsMatched files contained the Language Code '$LangAbbrev' ($LangCode2).</text:p>" \
                                                                                          >> $DemoDoc
          fi                                                        # Done:if [ $FODTGen == 1 ]
        fi                                                          # Done: if [ $LangAbbrev ]
      fi                                                            # Done: if [ $FinalLangCount != 0 ]
    else
      if [ $LangAbbrev ]; then
```

```
        printf "                %5d of those $FontsMatched files contained the Language Code '$LangAbbrev'\
 ($LangCode2).\n" ${LangsMatched[$LangIdx]}
        if [ $FODTGen == 1 ]; then                                # If an .fodt file was requested
          printf "   <text:p >                %5d of those $FontsMatched files contained the Language Code\
 '$LangAbbrev' ($LangCode2).</text:p>\n" ${LangsMatched[$LangIdx]} >> $DemoDoc
        fi                                                        # Done:if [ $FODTGen == 1 ]
      fi                                                          # Done: if [ $LangAbbrev ]
    fi                                                            # Done: if [ $LangMatchFailures != 0 ]
  fi                                                              # Done: if [ $LangCode != '99' ]
done                                                              # Done: for LangIdx in `seq 1 $NumArgs...
printf "%21s %s\n" "                 " $MiniSeparator             # Separate Lang Code stats from OTFCap

# Print results of the Open Type language support in the fonts ...
OTCapIdx=0                                                        # OpenType Capabilities: Index for array
for OneCap in $OTFCapList; do                                     # Report OTF capability for each font
  ((OTCapIdx++))
  OTFMatchSuccesses=${OTFMatches[$OTCapIdx]}
  MissingOTFMatches=${OTFMatchFailures[$OTCapIdx]}
  if [ $MissingOTFMatches != 0 ]; then
    printf "        WARNING:%5d of those $FontsMatched files contained the ISO 15924 Script Code '$OneCap',\
 BUT: $MissingOTFMatches FILE(s) DID NOT!\n" $OTFMatchSuccesses
    if [ $FODTGen == 1 ]; then
      printf "   <text:p >        WARNING:%5d of those $FontsMatched files contained the ISO 15924 Script\
 Code '$OneCap', BUT: $MissingOTFMatches FILE(s) DID NOT!</text:p>\n" $OTFMatchSuccesses  >> $DemoDoc
    fi                                                            # Done:if [ $FODTGen == 1 ]
  else
    printf "                %5d of those $FontsMatched files contained the ISO 15924 Script Code\
 '$OneCap'.\n" $OTFMatchSuccesses
    if [ $FODTGen == 1 ]; then
      printf "   <text:p >                %5d of those $FontsMatched files contained the ISO 15924 Script\
 Code '$OneCap'.</text:p>\n" $OTFMatchSuccesses  >> $DemoDoc
    fi                                                            # Done:if [ $FODTGen == 1 ]
  fi                                                              # Done: if [ $MissingOTFMatches != 0 ]
done                                                              # Done: for OneCap in $OTFCapList
printf "%21s %s\n" "                 " $MiniSeparator             # Separate OTFCap stats from CharMap

# Print results of the character set queries to the fonts ...
CMMIdx=0                                                          # Character Map Matches: Index for array
for CMap in $CMapList; do
  ((CMMIdx++))
  CMMatchSuccesses=${CMapsMatched[$CMMIdx]}
  MissingCMMatches=${CMapMatchFailures[$CMMIdx]}
  Seg=$(echo $CMap | cut -c 1-35)                                 # Truncated version for display only
  MiniSeg=$(echo $CMap | cut -c 1-13)                             # Truncated version for WARNINGs only
  if [ $MissingCMMatches != 0 ]; then
    printf "        WARNING:%5d of those $FontsMatched files contained the Character Map segment beginning\
 '$MiniSeg', BUT: $MissingCMMatches FILE(s) DID NOT!\n" $CMMatchSuccesses
    if [ $FODTGen == 1 ]; then
      printf "   <text:p >        WARNING:%5d of those $FontsMatched files contain the Character Map segment\
 beginning '$Seg', BUT: $MissingCMMatches FILE(s) DID NOT!</text:p>\n" $CMMatchSuccesses  >> $DemoDoc
    fi                                                            # Done:if [ $FODTGen == 1 ]
  else
    if [ $MissingCMMatches ]; then
      printf "                %5d of those $FontsMatched files contained the Character Map segment\
 beginning '$Seg'.\n" $CMMatchSuccesses
      if [ $FODTGen == 1 ]; then
        printf "   <text:p >                %5d of those $FontsMatched files contained the Character Map\
 segment beginning '$Seg'.</text:p>\n" $CMMatchSuccesses  >> $DemoDoc
      fi                                                          # Done:if [ $FODTGen == 1 ]
    fi
  fi
done                                                              # Done: for CSet in $CMapList; do

# Generate a file listing the matches that SUPPOSEDLY meet all our criteria:
if [ $FPassGen == 1 ]; then                                       # Switch set at beginning of this script
  for FNC in `seq 1 $ArgsFound`; do                               # Build out the file name
    LLFN=$LLFN"_"${LangList[$FNC]}
  done
  LLFN=$Origin"/"$LLFN".txt"                                      # Add path and extension for permissions
  printf "%21s %s\n" "                 " $MiniSeparator           # Separate reporting section
  printf "                    > Created file $LLFN listing complete matches.\n" # Notify user of file name.
  printf "This file is: " $LLFN                                                          > $LLFN
  printf "Suitable Fonts for mixing multiple Scripts/Languages: \n"                     >> $LLFN
  printf "$MiniSeparator\n"                                                             >> $LLFN
  printf "The following directory tree(s) were examined: $Where2Look\n"                >> $LLFN
  printf "\n"                                                                           >> $LLFN
  printf "  $FullMatchListIdx fonts found of the $FontsChecked font files examined:\n"  >> $LLFN
  printf "    a) contained the characters: $CharMsg\n"                                  >> $LLFN
  printf "    b) reported the corresponding Language Code(s): $LangCodeList\n"          >> $LLFN
  printf "    c) reported the corresponding Script Code(s): $OTFCapList\n"              >> $LLFN
```

```
  printf "    d) matched all the defined Character Map Segment(s)\n"                          >> $LLFN
  printf "  $MiniSeparator\n"                                                                  >> $LLFN
  printf "\n"                                                                                  >> $LLFN
  printf "  A List of those potentially usable Font files (for further evaluation) is:\n"     >> $LLFN
  for Id in `seq 1 $FullMatchListIdx`; do                          # Create the actual list of fonts
    printf "%5s: %s\n" $Id ${FullMatchList[$Id]}                                               >> $LLFN
  done
fi                                                                 # Done: if [ $FPassGen == 1 ]

# Indicate on screen that the list of potentially faulty fonts was created and give its name
if [ $SuspectGen == 1 ]; then                                      # Switch set at beginning of this script
  printf "%21s %s\n" "                " $MiniSeparator             # Separate reporting section
  printf "                    > Created file $SFLFN listing possibly faulty fonts.\n"
fi                                                                 # Done: if [ $SuspectGen == 1 ]

echo $MajorSeparator                                               # Screen Report completed!

# Here we complete the .fodt output file with a summary; with echo, actual spaces can be used with echo.
if [ $FODTGen == 1 ]; then                                         # Switch set at beginning of this script
  echo '   <text:p/>'                                                                          >> $DemoDoc
  echo '  </office:text>'                                                                      >> $DemoDoc
  echo ' </office:body>'                                                                       >> $DemoDoc
  echo '</office:document>'                                                                    >> $DemoDoc
fi                                                                 # Done if [ $FODTGen == 1 ]

##### END OF CODE HERE ###########################################################################
```

APPENDIX

Much of this document gives the impression that OpenType is the only approach to implementing modern text layout technology. That isn't the case, but OpenType seems to be the wave of the future for a number of reasons. For those who wish to explore this subject more thoroughly, there are at least two other approaches worth mentioning – both of which require fonts to incorporate instructions internally as OpenType does.

Apple Advanced Typography (AAT) is used on the Mac OS X operating system, and handles a wide variety of typographic chores, including all of the features described in the Design Note *Exploring Alphabets*. In practice, not many applications make use of this, however. See https://en.wikipedia.org/wiki/Apple_Advanced_Typography for more information.

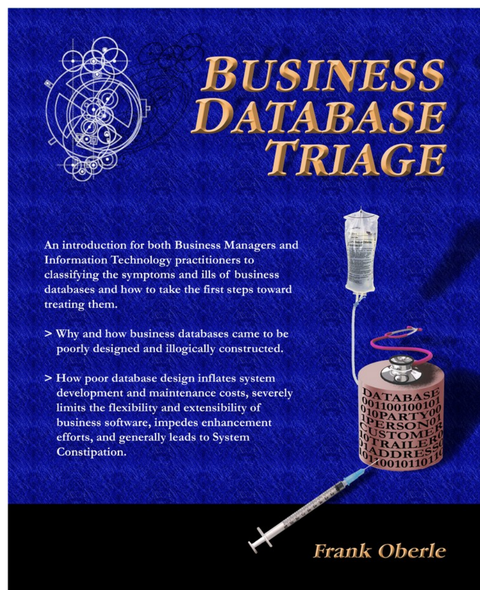
Graphite, available from SIL for a variety of operating systems. This also provides comprehensive control of font features discussed so far in this series. For further discussion of Graphite, see http://scripts.sil.org/cms/scripts/page.php?site_id=projects&item_id=graphite_home or https://en.wikipedia.org/wiki/Graphite_(SIL); informative commentary by the noted author Bruce Byfield when Graphite technology was introduced can be found at https://www.linux.com/news/graphite-smart-font-technology-comes-foss.

The difficulty with all such typography control mechanisms is a decided lack of any reasonably user-friendly interfaces. Selecting attributes such as bold or italic can be accomplished in a variety of relatively simple means by most users. OpenOffice and LibreOffice introduced support for Graphite features some time ago, and a Typography toolbar extension was provided to assist with using the features of the very few fonts containing Graphite instructions and alternate glyphs. For whatever reason, the toolbar is no longer actively supported. The current version of LibreOffice includes these instructions:

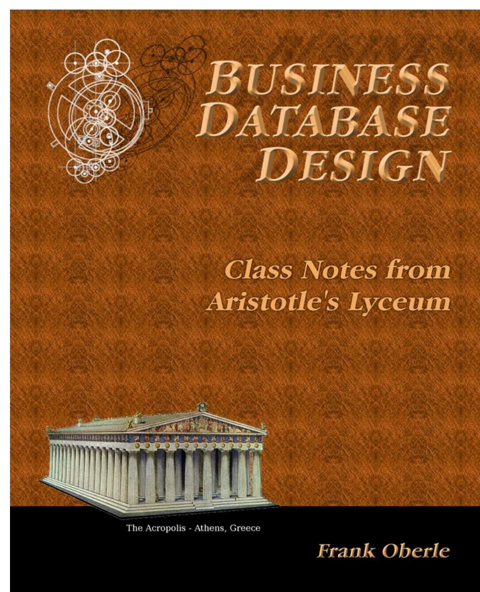
> *Users of In LibreOffice the font features can be turned on by choosing the font (ie Charis SIL), followed by a colon, followed by the feature ID, and then followed by the feature setting. So, for example, if the Uppercase eng alternate "Capital N with tail" is desired, the font selection would be "Charis SIL:Engs=2". If you wish to apply two (or more) features, you can separate them with an "&". Thus, "Charis SIL:Engs=2&smcp=1" would apply "Capital N with tail" plus the "Small capitals" feature.*

The problem, it seems, is coming up with some paradigm that permits much easier or convenient application of these advanced typography features for those who wish to use them, but remains out of the way of those with no interest.

Other Publications



More information and sample pages at:
www.AntikytheraPubs.com



Antikythera Publications

In addition to an ongoing series of Database Design Notes, Antikythera Publications recently released the book “*Business Database Triage*” (ISBN-10: 0615916937) that demonstrates how commonly encountered business database designs often cause significant, although largely unrecognized, difficulties with the development and maintenance of application software. Examples in the book illustrate how some typical database designs impede the ability of software developers to respond to new business opportunities – a key requirement of most businesses.

A number of examples of solutions to curing business system constipation are presented. Urban legends, such as the so-called object-relational impedance mismatch, are debunked – shown to be based mostly on illogical database (and sometimes object) designs.

“*Business Database Triage*” is available through major book retailers in most countries, or from the following on-line vendors, each of which has a full description of the book on their site:

CreateSpace: https://www.createspace.com/4513537

Amazon:

www.amazon.com/Business-Database-Triage-Frank-Oberle/dp/0615916937

A follow-up book, “*Business Database Design – Class Notes from Aristotle’s Lyceum*” is due to be available in the latter part of 2014.

“*Business Database Design*” leads the reader through the logical design and analysis techniques of data organization in more detail than the earlier work – which concentrated more on understanding and identifying problems caused by illogical database design rather than their solutions.

These logical approaches to data organization, espoused by Aristotle and an “A-List” of his successors, have formed the basis for scientific discovery over more than 2,400 years, and directly led to the technology we deal with today, notably including both relational and object theory.

“*Business Database Triage*” explained the reasons why these principles were virtually impossible to apply during the early years of our transition to the use of computers in business, but since the technology is now sufficiently mature that such compromises can no longer be justified, the time has come to relearn logical data organization techniques and apply them to our businesses.