# Unicode Issues in Perl


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# A Few Unicode Facts

- ☆ Not “characters”, but “Code-Points” in the range of U+00’0000 to U+10’FFFF
- ☆ Short designation: U+hhhh
- ☆ Includes a “code point” for each and every conceivable character in all conceivable “scripts”:
  - “Scripts”, as opposed to “Languages”. For example, Chinese, Japanese and Korean share the same script.
  - 93 scripts as of v. 6.0, including for example Egyptian Hieroglyphs
  - Numbers, General Punctuation, General Symbols, Mathematical Symbols, Musical Symbols, Technical Symbols, Dingbats, Arrows, Braille Patterns and more
- ☆ Hebrew occupies code points U+0590 to U+05FF

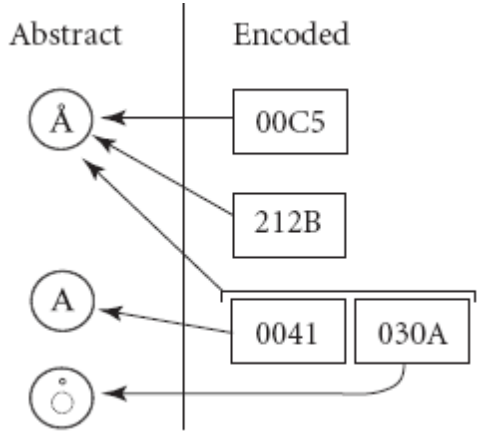
# A Few Unicode Facts (cont.)

- ☆ Unicode includes rules for the support of Bi-Directional (Bi-Di) text
- ☆ However, when "Unicode support" is claimed, it does not imply Bi-Di support, and it seldom does!
  - According to some claims, the official Unicode Bi-Di algorithm sucks…
- ☆ It supports the notion of a “paragraph” and a forced new-line (i.e., one that doesn’t terminate a paragraph)
- ☆ It supports all kind of text directions
  - LTR, RTL, and one embedded within the other (Bi-Di),
  - Top-to-bottom, bottom-up with “lines” going either from left-to-right or right-to-left
  - Boustrophedon: early Greek and Egyptian hieroglyphs used it. It Literally means “ox-turning”

# A Few Unicode Facts (cont.)

Example (Egytian Hieroglyphs)

☆ Supports both fully formed and superimposed diacritics (ניקוד" - פחות או יותר") on a bare base code-point



# Encodings

- ☆ "Encoding" only applies to I/O and files:
  - Text files
  - Downloaded Internet pages
  - Software source code (hence strings in it)
  - Text streams
  - etc.
- ☆ It is *not* (necessarily) how it is coded in memory
- ☆ Databases, editors, compilers, etc. can *read and/or write* (e.g. UTF-8) Unicode encoded text, but it doesn't necessarily mean that they *internally* represent text as "encoded" Unicode!
- ☆ Current encodings are only UTF-8, UTF-16 and UTF-32
- ☆ Older, deprecated encodings are UCS-2, UCS-4 and UTF-7)
- ☆ Practically, I never encountered anything other then UTF-8…

# Encodings (cont.)

☆ UTF-8:

- variable length encoding, 1-4 bytes.
- code-points in the range 0-127 are identical to “pure” ASCII encoding (please note, 7-bit ASCII, not 8-bit Latin-1!)
- Encoding:

| Code Points U+xx xxxx | 1st Byte | 2nd Byte | 3rd Byte | 4th Byte |
|---|---|---|---|---|
| 0aaa aaaa | 0aaaaaaa | | | |
| 0000 0bbb bbaa aaaa | 110bbbbb | 10aaaaaa | | |
| cccc bbbb bbaa aaaa | 1110cccc | 10bbbbbb | 10aaaaaa | |
| 000d ddcc cccc bbbb bbaa aaaa | 11110ddd | 10cccccc | 10bbbbbb | 10aaaaaa |

- Hebrew UTF-8 encoding is therefore in the range of 0xD690 to 0xD7BF

# Encodings (cont.)

- ☆ UTF-16 encoding
  - Variable length, one or two 16-bits units
  - Code points in the range U+0000..U+FFFF are represented as a single 16-bit code unit.
  - This range contains the vast majority of common-use characters for all modern scripts of the world.
  - Lookup “Unicode surrogate code points” for further details.
- ☆ UTF-32: the simplest one of all, where each code point is directly represented by a single 32-bit unit (word).
- ☆ One must know beforehand for the last two encodings on what “Endianess” was it originated, otherwise it would be impossible to interpret it.
- ☆ A Byte-Order-Mark (BOM) of U+FFFE, as the first code-point provides such a clue.

# The Perl UTF8(*) flag

- ☆ Internally, Unicode strings are encoded as either ISO-8859-1 or UTF8.
- ☆ A flag, called "SvUTF8", a.k.a. "the UTF8 flag", is set to 1 for strings that are UTF-8 internally, and to 0 for strings that are ISO-8859-1
- ☆ Once the UTF8 flag is set, Perl does not check the validity of the UTF8 sequences further. *This might be a security breach*
- ☆ The :utf8 PerlIO layer sets the UTF8 flag, without checking the byte sequences, on incoming data.
- ☆ This is not a bug or a flaw, but the very function of this PerlIO layer.
- ☆ It is used internally by other layers (most importantly the :encoding layer), after they have (safely) converted the input to internal Unicode.
- ☆ So, for your own protection, instead of the :utf8 PerlIO layer, use :encoding(UTF8) or :encoding(UTF-8)

# Perl Support

☆ “Support” means dealing in Perl with Unicode in:

- Strings
- Text I/O
- Regular Expressions
- Normalization

# Perl Strings

- ☆ As of Perl 5.8.1, the Perl native internal representation of strings is Unicode.
- ☆ You will find in many, even in canonical, Perl documents that this representation is UTF-8.
- ☆ There are some indications that this is “almost true” (as in “almost dead”???)
- ☆ If it is indeed true, then IMHO it is not wise. Think of all the overhead required to decipher the actual length in bytes…
- ☆ The good part is that you don’t need to know its internal representation!
- ☆ Even more, you should *never use or rely* on its internal structure. Here today, gone tomorrow…

# Perl Strings (cont.)

- To make Perl's recognize Unicode strings in your source code, you *must* insert the pragma:

```
use utf8;
```

- Once you did that, you can use Unicode strings as you would any other string: e.g., one can do translation as follows:

```
my %ID_types = (
  'מספר תעודת זהות'              => 'IL_ID',
  'מספר ברשם החברות בישראל'      => 'IL_CorpID',
  'מספר ברשם'                    => 'IL_CorpID',
  'מספר ברשם השותפויות בישראל'   => 'IL_PartnerID',
  'מספר דרכון'                   => 'Passport',
  'מספר רשם בארץ ההתאגדות בחו"ל' => 'ForeignCorpID',
  'מספר ביטוח לאומי'             => 'SSN',
  'מספר מזהה אחר'                => 'OtherID'
);

$Eng_ID_type = $ID_types{'מספר ברשם'};
```

# An Important Note

- ☆ From personal bad experience, even if :
  - Your source script is saved in Unicode/UTF-8 (or other) encoding,
  - It looks right in your Unicode/UTF-8/whatever favorit editor,
  - The encoding specification in the "open" statement (more on this in a moment) of output files is UTF-8, and/or…
  - … you placed a 'binmode' statement with its (optional) encoding as Unicode/UTF-8 (
- ☆ It ***Will NOT*** produce legible Unicode (e.g. Hebrew) text in the output file,
- ☆ UNLESS a «`use utf8;`» pragma is specified!!!
- ☆ Again, I am referring to strings *which are part of the script code*!
- ☆ However, Unicode text read as such from a file or downloaded from a web site and then written out and properly I/O encoded will be fine. Only strings in the body of the code require this pragma!

# Unicode Collation

- ☆ The Unicode Collation Algorithm (UCA) defines several levels of collation strength:
  - Level 1: ignoring case and diacritics, examining basic characters only
  - Level 2: adds diacritic comparisons to the ordering algorithm
  - Level 3: adds case ordering
  - Level 4: adds a tiebreaking comparison (sorry, can't explain… ☹)

  Level 4 is the default
- ☆ In simple terms, you can use collation strength to tell a UCA-aware sort to ignore case or diacritics.

```
use Unicode::Collate;
my $col = Unicode::Collate->new(level => 1);
my @list = $col->sort(@old_list);
```

# Perl Unicode I/O

☆ Declaring I/O default encodings:

```
use open OUT => ":encoding(UTF-8)";
use open IO  => ":encoding(iso-8859-7)";
```

(Importing non-Unicode text to a Unicode processing environment)

☆ Or, on an “open” by “open” basis:

```
open(my $fh, "<:encoding(windows-1255)", $filename);
```

- This also avoids the “**`Wide character in print`**…” warnings
- There are other good reasons to use this 3-arguments version of “open”

☆ To avoid “Wide character in print…” warnings in STDOUT and STDERR, you are advised to place

```
binmode STDOUT, ":encoding(UTF-8)";
```

(which will nevertheless display garbage on an MS-Windows ‘cmd’ window when emitting Hebrew text)

# An Alternative Approach*

- ☆ One can work with all texts as binary data (8-bit bytes) when
  - loading,
  - saving,
  - passing,
  - concatenating and…
  - … other simple operations
- ☆ Then, when the need arises to distinguish between chars and bytes, one can apply:
  - `decode_utf8` on bytes
  - `encode_utf8` on chars when
- ☆ Which requires the `use encode;` pragma

* As per Mikhael Goikhman's suggestion

# DBD/DBI, MySQL and Unicode

```
my %conn_attrs = (RaiseError=> $RaiseError,
                  PrintError => $PrintError,
                  AutoCommit => $AutoCommit,
                  mysql_enable_utf8 => 1);

my $dbh = DBI->connect
          ($dsn, $user_name, $password, \%conn_attrs);
```

# Hebrew HTML page scrapping example

- We downloaded a Hebrew HTML file, `windows-1255` encoded, and to build an `HTML::TreeBuilder` object from it. We start by:

```
my $root = HTML::TreeBuilder->new();
```

- Although there is a TreeBuilder method `$root->new_from_file($filename)` to do it directly…
- … it assumes a default UTF-8 file contents encoding.
- It will therefore not work with a `windows-1255` encoded file!
- Rather, one must first "open" the file, thus giving us an opportunity to specify its encoding and use another method to parse it:

```
open(my $fh, "<:encoding(windows-1255)", $filename);
$root->parse_file($fh);
```

(This method can accept either a file-name or a file-handle)

# Another Example

☆ What if we are downloading a *page* rather than a *file*:

```
use Encode qw(encode decode);

my $response      = $mech->get($url);
my $page          = $response->content();
my $unicoded_page = decode("windows-1255", $page);
my $root          = HTML::TreeBuilder->new_from_content($unicoded_page);
```

# Unicode Regular Expressions

- ☆ The Unicode Consortium specified three levels of RegEx support, “Basic”, “Extended” and “Tailored”, see Technical Standard #18.
- ☆ Perl versions supports most of the first and very little of the other two
- ☆ Perl 5.14 added more support and Perl 5.16 even more
- ☆ You can usually use Unicode strings as RegEx patterns
- ☆ Unicode defines :
  - Character names (e.g., “HEBREW LETTER ALEF”)
  - Character properties (e.g., “Lowercase_Letter”)
  - Script names (e.g., “Tamil”)
- ☆ You can specify all these by an escape `\p{}` and `\P{}`, e.g.:
  - `\p{Hebrew}` (any Hebrew character)
  - `\P{HEBREW POINT HOLAM}` (any character except one with a חולם)

# Equivalence

- ☆ Unicode heroically tried to be as backward compatible as possible with previous “locals” and “code-pages”.
- ☆ What made life difficult was:
  - Diacritics: the lowercase letter "ñ" of the Spanish alphabet can be set as either:
    - *A single code point U+00F1, or*
    - *code point U+006E (Latin lowercase "n") followed by U+0303 (the combining tilde "◌̃")*
  - Multiple Diacritics and/or Ligatures:
    - *A given base character or a ligature can be assigned multiple additions.*
    - *For example, Hebrew with both ניקוד and טעמי המקרא:*

U+05E7 – HEBREW LETTER QOF followed by
U+0593 – HEBREW ACCENT SHALSHELET, and then by
U+05B8 – HEBREW POINT QAMATS

    - *Since these might be entered manually, they might come in any order.*

# Equivalence (cont.)

- ☆ **Canonical** Equivalence:
  - Code point sequences that are defined as **canonically equivalent** are assumed to have the **same appearance and meaning** when printed or displayed.
  - Those sequences should be displayed in the same manner, should be treated in the same way by applications such as sorting or searching, and may be substituted for each other.
- ☆ **Compatibility** Equivalence:
  - Sequences assumed to have possibly distinct *appearances*, but the same *meaning* in “some contexts”.
  - For example, the code point U+FB00 (the typographic ligature "ff") is defined to be compatible — but not canonically equivalent — to the sequence U+0066/U+0066 (two Latin "f" letters).

# Equivalence (cont.)

- ☆ Sequences that are canonically equivalent are also compatible, but the opposite is not necessarily true.
- ☆ Compatible sequences may be treated the same way in some applications (such as sorting and indexing), but not in others
  - Sorting and searching might treat it the same
  - Page rendering applications will most probably consider them distinct
- ☆ They may be substituted for each other in some situations, but not in others.

# Normalization

- ☆ Unicode string searches and comparisons in text processing software must take into account the presence of equivalent code points.
- ☆ In the absence of this feature, users searching for a particular code point sequence would be unable to find other visually indistinguishable glyphs that have a different, but canonically equivalent, code point representation.
- ☆ **Unicode normalization** replaces equivalent sequences of characters so that any two texts that are equivalent will be reduced to the same sequence of code points.
- ☆ Unicode defines two normal forms:
  - **A fully composed** one, where multiple code points are replaced by single points whenever possible;
  - A **fully decomposed** one, where single points are split into multiple ones. Each of these four normal forms can be used in text processing.

# Unicode normalization forms

Unicode defines four normalization “forms” (of a given character):

| | |
|---|---|
| **NFD**<br>*Normalization Form (Canonical) Decomposition* | Characters are decomposed by *canonical* equivalence, and multiple combining characters are arranged *in a specific order*. |
| **NFC**<br>*Normalization Form (Canonical) Composition* | Characters are decomposed and then recomposed by *canonical* equivalence. |
| **NFKD**<br>*Normalization Form Compatibility Decomposition* | Characters are decomposed by *compatibility*, and multiple combining characters are arranged *in a specific order*. |
| **NFKC**<br>*Normalization Form Compatibility Composition* | Characters are decomposed by *compatibility*, then recomposed by *canonical* equivalence. |

# Normalization (cont.)

- ☆ Unicode provides standard normalization algorithms (plural…!)
- ☆ These produce a *unique* (normal) code point sequence for all sequences that are *equivalent*
- ☆ All four were implemented by Perl package (so I am told…):

*(From the Unicode cookbook)*

```
use Unicode::Normalize;
while (<>) {
    $_ = NFD($_); # decompose + reorder canonically
    ...
}
continue {
    print NFC($_); # recompose (where possible) + reorder canonically
}
```

# More…

- ☆ "The Absolute Minimum Every Software Developer Absolutely, Positively Must Know About Unicode and Character Sets (No Excuses!)“ by Joel Spolsky
  http://joelonsoftware.com/articles/Unicode.html
- ☆ The Unicode Standard
  http://www.unicode.org/
  (easy reading, all 670 pages of it…)
- ☆ Unicode Standard Annex #9 Unicode Bidirectional Algorithm
  http://www.unicode.org/reports/tr9/
- ☆ Perl Unicode Tutorial
  http://perldoc.perl.org/perlunitut.html
- ☆ Unicode support in Perl
  http://perldoc.perl.org/perlunicode.html
- ☆ Perl Unicode FAQ
  http://perldoc.perl.org/perlunifaq.html

# and even more…

- ☆ Analyzing Unicode Text with Regular Expressions
  by Andy Heninger (IBM Corporation)
  http://icu-project.org/docs/papers/iuc26_regexp.pdf
- ☆ UTF8 related exploit (PerlMonks post)
  http://www.perlmonks.org/?node_id=644786
- ☆ **Unicode and Passwords** by Ovid
  http://blogs.perl.org/users/ovid/2012/02/unicode-and-passwords.html
- ☆ **Why Unicode Normalization Matters** by chromatic
  http://www.modernperlbooks.com/mt/2013/01/why-unicode-normalization-matters.html

- ☆ **And, for a day-to-day work, until you are versed, use**
  Tom Christiansen's **Perl Unicode Cookbook**
  http://www.perl.com/pub/2012/04/perlunicook-standard-preamble.html