The CJK package for LaTeX 2$_\varepsilon$ — Multilingual support beyond babel

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Abstract

With Mule (multilingual Emacs) you can write texts in multiple languages. This editor is especially designed to handle the various encodings and character sets of Asian scripts such as Big 5 and GB for Chinese, JIS for Japanese, etc. Even more, you can use multiple CJK character sets simultaneously which enables e.g. Chinese users to write simplified (*jiǎntǐzì* 简体字) and traditional Chinese characters (*fántǐzì* 繁體字) at the same time.

The CJK package is the analogue to LaTeX 2$_\varepsilon$ (to be run under standard TeX). Most of the CJK (Chinese/Japanese/Korean) encodings are implemented; an interface between Mule and LaTeX 2$_\varepsilon$ is provided by an output encoding filter for Mule. CJK is of course not restricted to Mule. Any editor/environment which is able to handle double byte encodings can be used.

If you restrict babel to (7-bit) ASCII as the input encoding it is possible to embed babel into CJK seamlessly. Using Mule's output filter, you even don't need enter LaTeX-specific accent macros; the accented characters will be converted automatically.

Included in the CJK package are auxiliary programs which can convert CJK TrueType and bitmap fonts into pk files.

Introduction

TeX (and thus LaTeX) is an extremely flexible text formatting system which supports some multilingual features since the final version 3, mainly by allowing 8-bit input and fonts. But for CJK languages (Chinese/Japanese/Korean) this is still not enough because all encodings have more than 256 characters each.

The aim of the CJK package is to provide multibyte encoding support for LaTeX 2$_\varepsilon$ without any specific extensions of TeX. It contains modules for GB and Big 5 (Chinese), JIS and SJIS (Japanese), and KS (Korean) encoding, to name a few. In section "Unicode" on page 219 you'll find some notes on the pros and cons of Unicode in relation to TeX.

As far as I know there is only one freely available editor which is capable to display multiple character sets at the same time: Mule, the multilingual extension of Emacs.[1] A special output filter for Mule converts the internal encoding of Mule directly into something LaTeX can understand. See the section "The interface between Mule and CJK" on page 220 for more details.

Among other utilities two font converters called hbf2gf and ttf2pk are provided to convert CJK fonts into pk and tfm fonts; both programs are discussed in another paper of the proceedings ([8]).

The latest version of CJK can be found on CTAN in the directory language/chinese/CJK; various basic bitmap font packages are provided in fonts/CJK.

CJK encoding schemes

It is not possible to represent CJK character sets with one byte per character. At least two bytes are necessary, and most of the common CJK encoding schemes (GB, Big 5, JIS, KS, etc.) use a certain range for the first byte (usually 0xA1 to 0xFE or a part of it) to signal that this and the next byte represent a CJK character. As a consequence, ordinary ASCII characters (i.e., characters between 0x00 and 0x7F) remain unaffected.

[1] The next major releases of the various Emacs flavours (GNU Emacs and XEmacs) will merge the features of Mule back into Emacs.

encoding	1. byte	2. byte	3. byte
GB	0xA1–0xF7	0xA1–0xFE	—
Big 5	0xA1–0xF9	0x40–0xFE	—
JIS	0xA1–0xF4	0xA1–0xFE	—
SJIS	0xA1–0xFE	0x40–0xFC	—
KS	0xA1–0xFD	0xA1–0xFE	—
UTF 8	0xC0–0xEF	0x80–0xBF	0x80–0xBF
CNS	0xA1–0xFE	0xA1–0xFE	—

Figure 1: encoding schemes implemented in CJK

Some notes on the various encodings given in figure 1:

- SJIS, also known as MS-Kanji, consists of two overlaid character sets: the so-called halfwidth Katakana (JIS X0201-1976, 1-byte characters encoded in the range `0xA1` to `0xDF`) and the (fullwidth) JIS character set (JIS X0208-1990, mapped to the remaining code points).
- Some encoding schemes (Big 5, SJIS) have gaps in the range of the second byte.
- UTF 8 (Unicode Transformation Format 8), also called UTF 2 or FSS-UTF, is a special representation of Unicode (resp. ISO 10 646). It uses multibyte sequences of various length, but only 2-byte and 3-byte sequences are implemented in CJK. ASCII characters will be used as-is — without this property it would be impossible to use UTF 8 with TeX.
- CNS is defined to have 16 planes with 94×94 characters. Currently 7 planes are assigned (CNS 1 to CNS 7, an eighth plane has been said to be under development).
- It's difficult to input Big 5 and SJIS encoding directly into TeX since some of the values used for the encodings' second bytes are reserved for control characters: '{', '}', and '\'. Redefining them breaks a lot of things in LaTeX; to avoid this, preprocessors are normally used which convert the second byte into a number followed by a delimiter character.

For further details please refer to [10]; Lunde discusses in great detail all CJK encodings which are or have been in use. See also the section "Input encodings, output encodings, character sets" below.

The CJK package in detail

An example. Here a small lucullic text:

```
\documentclass{article}

\usepackage{CJK}
\usepackage{pinyin}

\begin{document}

\begin{CJK}{Bg5}{fs}

我很喜歡吃中國飯。

\Wo3 \hen3\xi3\huan1 \chi1
\Zhong1\guo2\fan4.

I like to eat Chinese food
very much.

\end{CJK}

\end{document}
```

The result looks like this:

> 我很喜歡吃中國飯。
> Wǒ hěn xǐhuān chī Zhōngguófàn.
> I like to eat Chinese food very much.

This example shows that basically only two steps are necessary to write Chinese: loading CJK with `\usepackage{CJK}` and opening a CJK environment. `Bg5` selects the Big 5 encoding for Chinese written with traditional characters, `fs` the font to be used (in this case it is *fǎngsòngtǐ* 仿宋體). The procedure is slightly different if you use `cjk-enc.el` and will be described below in the section "The interface between `Mule` and CJK" on page 220.

`\usepackage{pinyin}` loads the pinyin package which is also part of CJK. It enables input of *pīnyīn* syllables, the transcription system of Chinese used in Mainland China (see also the section "The pinyin package" on page 221).

Basic concepts. To understand how CJK works behind the scenes some basic concepts have to be introduced.

Input encodings, output encodings, character sets. Since the arrival of NFSS input and output encodings are clearly separated in LaTeX. With CJK encodings the situation is a bit more complicated because some encodings are input and output encodings *at the same time*. To make things even more confused, they can form a character set also!

Consider as an example Big 5. This is a character set developed by software companies in Taiwan for Chinese written with traditional Chinese characters. It is common practice to describe CJK character sets in rows, usually (but not necessarily!) represented by the first bytes of the output encoding. For Big 5 we have 94 rows of 157 characters each. Not all rows are fully occupied: $94 \times 157 = 14\,758$ characters are possible, but only 13 053 characters are really defined in the basic form of Big 5.[2] This character set can be split into three parts: 408 symbols (rows 1–3), 5 401 Level 1 hànzi (rows 4–38), and 7 652 Level 2 hànzi (rows 41–89). Level 1 contains the most frequent characters, Level 2 is an extension for rarely used characters occurring mainly in names.[3] With *hànzi* (漢字, *kanji* in Japanese, *hanja* in Korean) all ideographic glyphs derived from the Chinese script are denoted.

Row 1 of the Big 5 character set is mapped to `0xA1` as the first byte in Big 5 encoding, row 2 is mapped to `0xA2` etc.

You may ask: "Why only 157 characters per row? Table 1 would imply that 191 characters are available for each row." The answer is simple: due to historical reasons the range for the second byte of Big 5 input encoding (we are no longer talking about the Big 5 character set!) is split into two subranges: `0x40`–`0x7E` and `0xA1`–`0xFE`. And for convenience, almost all fonts providing the Big 5 character set can be accessed with an output encoding identical to the Big 5 input encoding.[4]

The counter example is the SJIS input encoding. Here we have two distinct Japanese character sets (JIS X0201 and JIS X0208) which will be accessed as two different fonts in the CJK package having a 1-byte and a 2-byte output encoding respectively.

The CJK macro layers. CJK makes all characters above `0x7F` active (except `0xFF`). The macro level assigned directly to the active characters is called 'binding' (stored in files with the extension `bdg`). The binding decides whether only the current byte, the next byte with the current byte or possibly the next two bytes together with the current byte represent a CJK character (example: JIS encoding has only 2-byte characters, SJIS has 1-byte and 2-byte characters).

The next level chooses the encoding of the CJK font and the output encoding of the subfonts (called 'fontencoding'; see also the sections "Subfonts" and "CJK font definition files" below for further information); the corresponding macros are stored in files with the extension `enc`. Here the proper subfont together with some font offsets will be selected and passed as arguments to the next level.

Macros from the third and last level (stored in files with the extension `chr`) finally select the proper character, check whether it is a special character etc., and print it out.

User selectable are only the encoding and fontencoding, the other levels are chosen automatically.

'Preprocessed' mode. Big 5 and SJIS encoding can't be handled well within TEX due to some characters in the range of the encodings' second bytes which interfere with the TEX control characters '`{`', '`}`', and '`\`'. It is possible to redefine them (and the CJK package provides two environments, Bg5text and SJIStext, which do exactly that), but many commands of LATEX don't work inside of them. Another annoying fact is that second bytes smaller than `0x80` are affected by case changing commands, altering the CJK characters!

Thus I have decided to program small preprocessors written in C[5] to convert the encodings into a form which won't cause problems: the second byte of an encoding will be converted into its decimal equivalent, followed by `0xFF` as a delimiter character.

This approach works for all encodings except UTF 8. CJK simply checks the precence of the `\CJKpreproc` command inserted by the preprocessor at the very beginning of the output file: if it is defined, another set of macros connecting the 'binding' and 'fontencoding' level is used. If it is undefined, `\MakeUppercase` is disabled for Big 5 and SJIS encoding.

Subfonts. What has been said about output encodings in a previous section is not the truth. It's a "little white lie", to cite a famous computer scientist whose name I can't remember yet.[6] To make large CJK fonts work with TEX we must split them. I've chosen the most compact subfont layout, i.e., 256 characters per subfont, but due to the modular concept of CJK it was not difficult to support other subfont schemes (like *poor man's Chinese* which uses one subfont per leading byte).

The number of subfonts per font is large. A JIS encoded font for example needs 35 subfonts, a Big 5 encoded font up to 55. See below the section

[2] See [10] for a complete description of the extensions to Big 5.

[3] Chinese names cause a great problem for electronic data processing since every year new characters are invented; this is quite common especially in Hong Kong.

[4] This has changed with the propagation of TrueType fonts where e.g. fonts with a Big 5 character set can be accessed as Unicode encoded *and* as Big 5 encoded, provided the font has mapping tables for both encodings. The same is true for the so-called CID PostScript fonts which also can use multiple mapping tables for a particular font.

[5] Former versions of CJK contained these preprocessors written in both TEX and C, but under `web2c` it is impossible to `\write` out real 8-bit characters larger than `0x7F` to a file; you will always get the `^^xx` notation which fails in verbatim environments.

[6] Nevertheless, it is the truth for Ω which can handle fonts with more than 256 characters.

"CJK font definition files" for the naming scheme of subfonts.

The interaction with NFSS. Today I'm suprised by myself how simple it has been to adapt NFSS to subfont selection; only one internal macro of the LaTeX 2ε kernel, namely `\pickup@font`, must be redefined to gain the additional subfont functionality needed by CJK.[7] Here is the version as implemented in `CJK.sty`:[8]

```
\def\pickup@font{
  \ifx\CJK@plane \@undefined
% old definition
    \expandafter\ifx\font@name \relax
      \define@newfont
    \fi
  \else
% CJK extension
    \expandafter
    \ifx\csname \curr@fontshape/\f@size/
                \CJK@plane\endcsname \relax
      \define@newfont
    \else
      \xdef\font@name{
        \csname \curr@fontshape/\f@size/
                \CJK@plane\endcsname}
    \fi
  \fi}
```

`\CJK@plane` is only defined inside of a CJK macro on the character level. It will contain the subfont plane to be used. The only purpose of the small extension in `\pickup@font` is to define or check a new `\font@name` by appending `\CJK@plane` to the name LaTeX would construct.

CJK font definition files. Font definitions for CJK fonts are basically similar to other fonts. The main difference is that you define *classes* of subfonts instead of a single font.

Subfont names. The default name of a CJK subfont is the font family name plus a running decimal number (normally consisting of two digits). Example: `b5ka1201`, `b5ka1202`, etc. Unicode encoded fonts have two running hexadecimal digits appended instead, and some Japanese and Korean fonts follow other naming conventions. For all declarations in font definition files you have to specify the font family only; in our example this would be `b5ka12`.

Size functions. A suite of additional font size functions which take care of the subfonts has been defined. Most of them have a 'CJK' prefix or postfix to standard LaTeX size function names (`CJK`, `sCJK`, `CJKsub`, ...) to indicate a similar behaviour. Additionally some CJK size functions have a 'b' postfix to select 'poor man's boldface', as I have called the emulation of bold fonts by printing a non-bold character thrice with small offsets.[9] Providing a boldface emulation proved to be necessary because most of the freely available CJK fonts are available in one (LaTeX) series only.

Here a sample entry for a GB encoded pixel font:

```
\DeclareFontFamily{C10}{fs}{}
\DeclareFontShape{C10}{fs}{m}{n}{
    <-> CJK * gsfs14}{}
\DeclareFontShape{C10}{fs}{bx}{n}{
    <-> CJKb * gsfs14}{\CJKbold}
```

`\CJKbold` sets an internal flag to switch on boldface emulation.

NFSS font encodings. Since version 4 of the CJK package all NFSS font attributes are supported. To achieve that it was necessary to have an NFSS font encoding for each CJK encoding. Figure 2 shows some of the currently available font encodings; all encodings defined by CJK start with an uppercase 'C', followed by two digits.

language	environment	NFSS encoding
Chinese:	Bg5	C00
	GB	C10
	CNS1–7	C31–37
Japanese:	JIS	C40
	JIS2	C50
	SJIS	C40 (fullwidth)
		C49 (halfwidth)
Korean:	KS	C60 (hanja)
		C61 (hangul)
Unicode:	UTF8	C70

Figure 2: The correlation between CJK encodings, CJK fontencodings, and NFSS font encodings. Only the most important encodings are listed here.

Some CJK encodings need more than one NFSS font encoding, as can be seen in the table (not listed here is the support for HLaTeX fonts where *four* NFSS encodings are necessary); the first digit usually represents the CJK encoding, the second digit (except for CNS encoded fonts) the specific subfont layout.

[7] `\selectfont` will also be changed slightly; nevertheless, it is not for the subfont selection but rather for the support of boldface emulation for CJK fonts.

[8] Please note that almost all files in the CJK package start with `\endlinechar -1` to avoid percent signs at the end of a line if we must suppress the newline character. The other TeX macro code fragments in this document assume the same.

[9] An explanation for the very reason of having extra size functions for bold face emulation is beyond the scope of this (already too long) article. It can be found in the documentation files of CJK.

The macro which internally maps the CJK encoding to one or more NFSS font encodings also calls `\DeclareFontSubstitution` with an empty font name macro to fake the fall-back mechanisms of NFSS.[10]

Nevertheless, you never access the NFSS font encodings directly; this will be done automatically if you open a CJK environment or use a `\CJKenc` command (see below).

CJK commands and environments. In this section you will find some important CJK commands not discussed elsewhere in this paper.

Additionally to the CJK environment CJK* will be provided: the starred form suppresses spaces after a CJK character (using `\ignorespaces`) which don't appear in texts written with Chinese or Japanese as the main language. To 'switch' from CJK to CJK* without leaving the environment you can use the `\CJKspace` command (and `\CJKnospace` for the other direction).

To access a CJK character directly you can use the `\CJKchar` command; it takes the first and second byte (represented as a number) of the character code together with an optional encoding string as parameters. This is the most portable form since no input characters larger than `0x7F` are used.

Four commands will control encodings and font encodings: `\CJKenc`, `\CJKfamily`, `\CJKencfamily`, and `\CJKfontenc`. To change the encoding inside of a CJK environment, use `\CJKenc`. It will always use the font encoding for a certain encoding which has been selected with `\CJKfontenc`. To change the font family you have two alternatives: The first is to define a family for a specific encoding with `\CJKencfamily`. If this encoding is chosen, the family defined in this way will be taken. The second is to specify a family for all encodings with `\CJKfamily`, overriding all `\CJKencfamily` commands. You must explicitly say '`\CJKfamily{}`' to reactivate any font definitions done with `\CJKencfamily`. Here is a (hypothetical) example:

```
\CJKencfamily{GBt}{hei}
\CJKfontenc{JIS}{dnp}

\begin{CJK*}{Bg5}{fs}    % this is equal to
                         % \begin{CJK*}{}{}
                         % \CJKenc{Bg5}
                         % \CJKfamily{fs}
..Text in Bg5 fangsong..% c00fs.fd used
\CJKenc{GB}
..Text in GB fangsong.. % c10fs.fd used
\CJKfamily{kai}
..Text in GB kai..      % c10kai.fd used
\CJKenc{JIS}
..Text in JISdnp kai..  % c42kai.fd used
\CJKfamily{}
\CJKenc{GBt}
..Text in GBt hei..     % c20hei.fd used
\end{CJK*}
```

'dnp' is the abbreviation for Dai Nippon Printing (大日本印刷), a great printing company in Japan providing Japanese TEX fonts. 'GBt' stands for GB traditional encoding (GB 12 345) — as far as I know no GB 12 345 font is freely available.

In case you get overfull `\hbox`es caused by CJK glyphs the macros `\CJKglue` and `\CJKtolerance` will help. The former is used for Chinese and Japanese encodings, defining the glue between CJK glyphs. Its default value is set to `\hskip 0pt plus 0.08\baselineskip`. The latter makes sense for Korean; the default value for `\CJKtolerance` is 400.

Only a subset of the commands available has been introduced here. For a complete description please refer to the various CJK documentation files.

CJK typography rules

Some special CJK characters should not start or end a line, e.g. various kinds of parentheses and many interpunctuation characters. In Japanese there is additionally a set of Hiragana and Katakana characters which are not allowed to start a line (*kinsoku shori* 禁則処理); both are supported automatically by CJK (but can be controlled if necessary). The mechanism to achieve this is quite tricky: usually you have some breakable glue (using `\hskip`) between two consecutive CJK characters (with other words, you need intercharacter spacing for Chinese and Japanese). Every character will be checked against encoding specific lookup tables whether it is a character not allowed to start or to end a line. In the former case, the glue before the character must be made unbreakable, otherwise the glue after the character.

No space will be printed after or before a CJK interpunctuation mark in Japanese and Chinese, but in Korean spaces are used between words[11] and after interpunctuation marks (which are in most cases the same as in Western languages).

[10] The latest version of HLaTeX has introduced 'HFSS' (the 'H' stands for Hangul), a font selection scheme to be run in parallel with NFSS, basically having an identical interface. A lot of advantages can be gained, mainly higher speed and better error handling.

[11] which are written as a combination with Hanja and Hangul (한글), the Korean syllabic script. No intercharacter glue is used but `\discretionary{}{}{}` instead; additionally `\tolerance` is increased to `\CJKtolerance`.

As explained above we have macros for all CJK characters. How can we test whether the previous character was a CJK character, maybe even a special one? It's impossible to use `\futurelet` or other such commands because this only works on TeX's macro level, not on horizontal lists which are eventually output to a `dvi` file.

The solution I've found finally uses `\lastkern` to check the amount of the last kern.[12] If the current character is an ordinary one, a kern of 1 sp is emitted (do you remember TeX's smallest unit?); if no break should occur between the current and the next character, a kern of 2 sp is used instead. Now the next character will be processed. If it is a CJK character, `\lastkern` is tested whether it is 1 sp or 2 sp, and the appropriate action is executed.

Another typographic rule in CJK text processing is the use of different spaces, depending on context. Between a CJK character and a non-CJK character (e.g. an English word to be cited or a number) only a space having the quarter width of a (fullwidth) kanji should be typeset, and between non-CJK characters the default space has to be used. This quarter space is called *shibuaki* (四分あき). Some Japanese standards define more sophisticated rules where to print which space, but even the simple problem with having two different space widths can't be solved automatically in standard TeX. There exist Japanese adaptations of TeX which handle this internally, but you can't use these programs with other CJK languages. Nevertheless, it is solvable within Ω; see [6] for a short discussion on this topic.

The only way to manage shibuaki is to insert them manually. For this purpose I've redefined the tilde character to insert a quarter space instead of an unbreakable space (this will be still available as `\nbs`, a shorthand for `\nobreakspace`). The command `\CJKtilde` activates it; here an example:

```
中國飯\ food 中國飯    中國飯 food 中國飯
中國飯~food~中國飯     中國飯 food 中國飯
```

'~' is defined as

```
\def~{\hspace{.25em plus .125em minus .08em}
```

The effect of '~' seems to be minimal, but in underfull boxes it is really an optical enhancement.

The *Chinese Encoding Framework* (CEF)

Christian Wittern, a former employee of IRIZ ([1]), now working at the University of Göttingen, has developed CEF. Its primary aim is to access seldom used CJK encodings (most notably CNS) in a platform independent way using SGML macros of the form '`&`<*encoding*>`-`<*code*>`;`'. Examples for valid encoding values are 'C3' for CNS plane 3, 'C0' for Big 5, 'U' for Unicode; the code is given as a hexadecimal number (see [15] for a detailed description).

He has also developed *KanjiBase for Windows*, an input tool for CEF which accesses a large CJK character database (which I consider the very heart of the whole system). It is also described in [15].[13]

A small example from an old Zen text (*The Records of Zhàozhōu* 趙州真際禪師語錄, taken from the IRIZ ZenBase CD 1) shows how it works:

```
0304a12
古尊宿語錄卷第十三。
趙州真際禪師語錄并行狀卷上〔南嶽下四世嗣南泉願〕。
師即南泉門人也。俗姓郝氏、本曹州郝鄉人也、諱從
諗。鎮府有塔記云、師得七百甲子歟。值武王微沐、避
地岨崍、木食草衣、僧儀不易。師初隨本師行&C3-3847;到南
泉。本師先人事了、師方乃人事。南泉在方丈內臥次、
見師來參、便問、近離什麼處。師云、瑞像院。南泉云、還
```

And here the same text with the appropriate CNS character:

```
0304a12
古尊宿語錄卷第十三。
趙州真際禪師語錄并行狀卷上〔南嶽下四世嗣南泉願〕。
師即南泉門人也。俗姓郝氏、本曹州郝鄉人也、諱從
諗。鎮府有塔記云、師得七百甲子歟。值武王微沐、避
地岨崍、木食草衣、僧儀不易。師初隨本師行脚到南
泉。本師先人事了、師方乃人事。南泉在方丈內臥次、
見師來參、便問、近離什麼處。師云、瑞像院。南泉云、還
```

The punctuation marks have been inserted by the editors and are not present in the original text.

CJK provides a small preprocessor to convert CEF macros into `\CJKchar` macros.

Unicode

Characters encoded in Unicode can't be used directly with TeX because the encoding is 16 bits wide. Instead, you have to use UTF 8 (see table 3 for the relationship between Unicode and UTF 8).

This multibyte representation has some important advantages: it is completely transparent for ASCII characters (you can always find the beginning of a multibyte sequence because the leading byte is unambiguously defined) and it is "reasonably compact in terms of number of bytes used for encoding", to quote from appendix A.2 of [13].

[12] Un Koaung-Hi (殷光熙), the author of HLaTeX ([12]) for Korean, uses a different solution: he modifies the space factor of specific characters to indicate a break point.

[13] You can find the latest version in [14] which also provides some online access and conversion.

Unicode	UTF 8		
	byte 1	byte 2	byte 3
00000000 $0b_6b_5b_4b_3b_2b_1b_0$ (`U+0000` – `U+007F`)	$0b_6b_5b_4b_3b_2b_1b_0$	—	—
$00000b_{10}b_9b_8$ $b_7b_6b_5b_4b_3b_2b_1b_0$ (`U+0080` – `U+07FF`)	$110b_{10}b_9b_8b_7b_6$	$10b_5b_4b_3b_2b_1b_0$	—
$b_{15}b_{14}b_{13}b_{12}b_{11}b_{10}b_9b_8$ $b_7b_6b_5b_4b_3b_2b_1b_0$ (`U+0800` – `U+FFFF`)	$1110b_{15}b_{14}b_{13}b_{12}$	$10b_{11}b_{10}b_9b_8b_7b_6$	$10b_5b_4b_3b_2b_1b_0$

Figure 3: The UTF 8 representation of Unicode

CJK supports the whole Unicode range, not only the CJK part (provided you have fonts available), but I think that only the CJK range of Unicode makes sense with TEX under normal circumstances. The main reason is that you can have neither kerning nor automatic hyphenation if two adjacent characters come from different fonts, and this is almost inevitable because the number of (precomposed) latin characters with diacritics exceeds 700, and composition doesn't help either since the usage of `\accent` prevents kerning and hyphenation...

Another reason is that most of the currently available Unicode encoded CJK fonts provide one glyph shape per code point. However, this is not enough for typographically correct output. In figure 4 you can see the same character in three different shapes. Ken Lunde shows in [9] that for a Unicode CJK font which really satisfies Chinese, Japanese, and Korean users about 40% more glyphs than code points are needed — this would further increase the number of TEX subfonts to be accessed simultaneously because the order of characters (or glyphs) in the CJK section of a Unicode font does not follow the character frequency but rather the order in a famous Chinese dictionary (*Kāngxī zìdiǎn* 康熙字典).

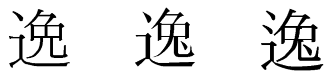


Figure 4: The Unicode character `U+9038` in Japanese, Chinese, and Korean form (from left to right)

The interface between `Mule` and CJK

Handa Ken'ichi (半田剣一), the main author of `Mule`, constructed a Lisp code frame for an interface between `Mule` and CJK which I filled with the needed values. It can be integrated into AUCTEX ([11]) without any great problems, making it a very convenient multilingual environment for LATEX.

The interface (stored in the file `cjk-enc.el`) has the form of a `Mule` output encoding. This means that you load a file into a `Mule` buffer, change the name of the buffer to the target file name, select 'cjk-coding' as the output encoding and save the file.

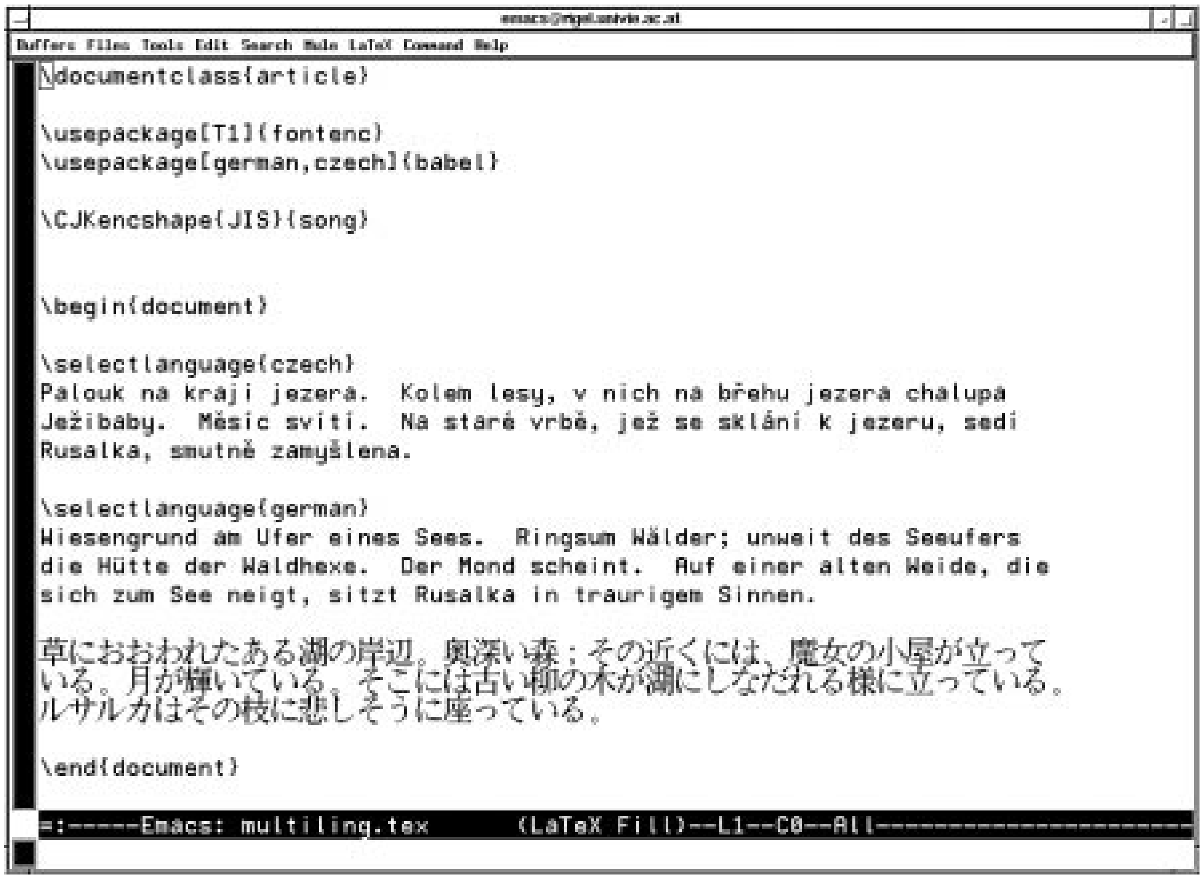
Look at figure 5. It shows a small multilingual example where Japanese is mixed with German and Czech.[14] As you can see, babel ([2]) is used for the two European languages; a CJK environment together with proper encoding switches is inserted automatically by the output encoding; accented characters are translated into LATEX macros also without any additional work.

It's not necessary to open a CJK environment inside of the document (it can even cause errors). Nor is it necessary to load the CJK package itself. The output filter uses `\RequirePackage` to load CJK and `\AtBeginDocument` to start a CJK environment with empty arguments; proper `\CJKenc` macros are inserted immediately before an encoding change. The most convenient way to specify CJK font shapes is then to use `\CJKencshape` in the preamble.

Now consider the word 'Dvořák' as an illustration of the hidden mechanism of the interface. `Mule`'s internal representation of this word is '`Dvo ^^82^^f8^^82^^e1k`' (`^^xx` denoting real 8-bit values); `^^82` is a leading byte representing the Latin-2 *character set*, `^^f8` and `^^e1` are the 'ř' and 'á' in Latin-2 *encoding*.[15] After applying the 'cjk-coding' output encoding (as defined in `cjk-enc.el`), the Czech name looks like this: '`Dvo^^8051^^ffr^^ff ^^8020^^ffa^^ffk`'. The active character `^^80` has basically the following definition (in `MULEenc.sty`

[14] The text has been taken from a synchronoptical translation of the libretto of Antonín Dvořák's opera *Rusalka*. The left column is printed in Czech (the original language), the middle column in German, and the right column in Japanese.

[15] This is a bit sloppy. To speak correctly I had to say that the right-hand part of Latin Alphabet Nr. 2 (as defined in ISO 8859/2 and registrated as IR 101 in [4]) is mapped to the GR (Graphic Right, `0xA0` to `0xFF`) area. See [3] for a concise description of the terms necessary to understand `Mule`'s internal and external code representations.



```
\documentclass{article}

\usepackage[T1]{fontenc}
\usepackage[german,czech]{babel}

\CJKencshape{JIS}{song}


\begin{document}

\selectlanguage{czech}
Palouk na kraji jezera.  Kolem lesy, v nich na břehu jezera chalupa
Ježibaby.  Měsíc svítí.  Na staré vrbě, jež se sklání k jezeru, sedí
Rusalka, smutně zamyšlena.

\selectlanguage{german}
Wiesengrund am Ufer eines Sees.  Ringsum Wälder; unweit des Seeufers
die Hütte der Waldhexe.  Der Mond scheint.  Auf einer alten Weide, die
sich zum See neigt, sitzt Rusalka in traurigem Sinnen.

草におおわれたある湖の岸辺。奥深い森；その近くには、魔女の小屋が立って
いる。月が輝いている。そこには古い柳の木が湖にしなだれる様に立っている。
ルサルカはその枝に悲しそうに座っている。

\end{document}

=:-----Emacs: multiling.tex      (LaTeX Fill)--L1--C0--All-----------------
```

Figure 5: A screen snapshot of `Mule`

which will always be `\input` at the very beginning of the output file):

```
\def^^80#1^^ff#2^^ff{...}
```

The first parameter is an index to an accent macro, the second is the letter (or character macro) to be modified. A number is used as the index; this has the advantage that it works in verbatim environments equally well as in case modifying commands. After expanding the macros `\mule@51` and `\mule@20` (defined with `\csname`) are called which finally expand to `\v` and `\'`. Great care has been taken to assure that really only expansion occurs to retain kerning.

Besides the common Latin and CJK character sets the `Mule` interface supports Vietnamese ([7]); it is planned to extend it to Thai and Russian soon.

Other tools

The pinyin package. This style file (which can be also used with plain TeX) enables the input of pīnyīn syllables with tones. An example of its usage was given on page 215.

Some additional notes:

- Mandarin Chinese has basically four tones (*sì shēng* 四聲) but sometimes it is referred to have a fifth, unstressed one. In the Chinese syllable script *zhùyīnfúhào* (注音符號) this fifth tone is indicated with a dot, but has no corresponding tone mark in pīnyīn. On the other hand, the first tone will be marked with a horizontal line in pīnyīn but remains unmarked in zhùyīnfúhào.

  With the pinyin package you can write e.g. '`\ma5`' to emphasize that you really mean an unstressed syllable — the result is equal to '`ma`'.
- In [16] a different approach to writing pīnyīn has been described; ligatures are used to compose vowels with tone marks, e.g. '`nu:v'e'r'`' to get nǚ'ér[16] (女兒, the Chinese word for daughter). The advantage is the avoidance of any macros to produce the accented letters. The disadvantage is that you need virtual fonts to

[16] The quote character is used to denote the syllable boundary in ambiguous cases.

realize the ligatures which are not as easily installed as a macro package because you have to *create* them first if you want to use a new font.

The ruby package. To cite Martin Dürst[17] who wrote a proposal for ruby in HTML documents:

> Ruby are small characters used for annotations of a text, at the right side for vertical text, and atop for horizontal text, to indicate the reading (pronounciation) of ideographic characters.
>
> [...]
>
> The name *ruby* is the name of the 5.5 point type size in British terminology; this was the size most used for ruby.
>
> [...]
>
> Ruby are in most cases set at half the size of the main letters, resulting in a possible two ruby characters per main character, and taking up half of the width of the main characters. However, at least up to five ruby characters per main character are possible (an example is *u-ke-ta-ma-wa-ru* ($\overset{うけたまわ}{承}$る, to listen respectfully), and so various solutions, from leaving white space in the main text to having the ruby overlap the next characters of the main text, are possible (the latter is possible in Japanese especially because in many cases, the characters around an ideograph with ruby are syllabic, and therefore the assignment of ruby to main characters poses no problems for the reader).
>
> [...]
>
> Ruby are particularly frequent in Japanese, because of the way CJK ideographs are used in Japanese. Ideographs can have many different readings (pronounciations) because different readings were taken over from different regions of China and at different times when the characters where adopted in Japan. Also, these characters are used to write indigenous Japanese words, and many readings may be possible because the ideograph might cover many different concepts distinguished in the Japanese language. [...] The main use of ruby today is in magazines of all levels, and of course in educational material. Ruby are also used in educational material in China and Taiwan.
>
> In Japan, the term *furigana* (ふりがな) is also used instead of ruby. 'Furigana' is composed of the verb *furu* ($\overset{ふ}{振}$る, to attach, sprinkle, ...) and *gana* ($\overset{が}{仮}\overset{な}{名}$, either hiragana or katakana, one of the two Japanese syllabaries usually used for ruby).

[17] His email address is `mduerst@ifi.unizh.ch`.

The ruby $\overset{うけたまわ}{承}$ of the above citation has been input as `\ruby{承}{うけたまわ}`; the first parameter is the base character and the second the ruby itself.

To avoid lines sticking together the ruby package sets `\lineskiplimit` to 1 pt. It may be necessary to increase this value for larger font sizes.

Whether a ruby overlaps with the surrounding characters or not can be controlled with the overlap and nonoverlap options. There are a number of possibilities how ruby can interact with other CJK characters in both cases.

- The ruby has a smaller width than its base character: the behaviour is identical to an ordinary CJK character.
- The ruby has a greater width than its base character:
  - Overlapping ruby:
    - If the previous or next character is a CJK character (ordinary or punctuation), insert unbreakable glue between.
    - If the previous or next character is a ruby, handle both ruby as non-overlapping and insert unbreakable glue between.
    - A ruby at the beginning of a paragraph will be treated as if the nonoverlap option had been set. To force an overlapping ruby you have to start the paragraph with a `\leavevmode` command.
  - Non-overlapping ruby: if the previous or next character is a CJK character (ordinary or punctuation), insert unbreakable glue between.

`ruby.sty` introduces a third variation of a small kern (3 sp) to inform the next CJK or ruby macro that the previous character was an overlapping ruby with the ruby's width greater than its base character. The global variable `\ruby@width` then contains this width.

The interface to the koma-script package

One of the greatest deficiencies of the current implementation of the standard document classes is the inflexibility in handling captions which follow non-English conventions. But even English captions can cause trouble if they are non-standard. Consider "Chapter Two" vs. "Second Chapter": the former is supported, the latter isn't. With 'supported' I mean that it is not necessary to rewrite any internal LaTeX commands, and that even a novice user can change it. Besides this, many languages, especially in Asia, follow different conventions how to numerate sections, figures, etc. A Chinese example: 'Chapter 5' is '第五章'. '第' (dì) is a prefix which converts the following Chinese number from a numeral into an ordinal, '第五' (dìwǔ) thus means 'the fifth'. '章' (zhāng) means chapter.[18]

Markus Kohm, the maintainer and developer of the koma-script package ([5]), has extended the package's document classes with a flexible hierarchical captioning model which consists of three levels, one level deeper than in standard LaTeX.

Level 1 are the well known standard macros `\figurename` etc. Language specific packages or options usually replace the English names with the right ones.

Level 2 is the modification of sectioning counters like `\thesection`. In the above example Chinese numbers should be used instead of Arabic digits.

Level 3 finally enables full control over the exact placement of spaces, counters, and other text in captions. All macros of this level have 'format' as postfix, e.g. `\chapterformat`; they are directly used by `\chapter`, `\section`, etc.

A simplified definition for a Chinese chapter heading macro would be:

```
\newcommand\CJKnumber[1]{
  \ifcase#1\or
  一\or二\or三\or四\or五\or
  六\or七\or八\or九\or十\fi}

\newcommand\prechaptername{第}
\newcommand\postchaptername{章}
\renewcommand\thechapter{
  \prechaptername
  \CJKnumber{\value{chapter}}
  \postchaptername}
\renewcommand\chapterformat{\thechapter}
```

The CJK package supports this interface and provides caption files for Chinese, Japanese, and Korean. To activate, say `\CJKcaption{xxx}` inside of a CJK (or CJK*) environment; then the language module `xxx.cap` will be loaded. The names of the modules usually mirror the encoding, e.g., the Chinese caption file in Big 5 encoding is named `Bg5.cap`.

[18] Often it is written like '第 五 章' (第\ \ 五\ \ 章) in chapter headings, but the form without spaces is used in the table of contents.

Conclusion

The CJK package works best if you write a document in a *non*-CJK language as the main language. Many typographic features needed for native CJK script support can't be handled automatically due to limitations in TeX itself (the abovementioned shibuaki problem, vertical typesetting,[19] and others).

Another not yet mentioned problem is speed. Due to the many (sub)fonts you have to change the font for almost each character — if your document consists entirely of, say, Chinese, you have more than enough time to drink a cup of coffee to format 50 pages on a moderately fast computer.

The future for CJK multilingual text processing with LaTeX is definitely Ω, but until someone will have found time to provide CJK support (it is highly probable that this person is me again), it may not be the worst choice to use the CJK package meanwhile.

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