Unicode and its   s: normalisation, Han unification and m  re

2018

https://github.com/gyng/book/tree/master/slides/unicode

Unicode and its □糞□香s: normalisation, Han unification and mΛΓore

2018 (Shift-JIS edition)

https://github.com/gyng/book/tree/master/slides/unicode

1. Some background
2. Unicode and UTF-x
3. Programmer pitfalls

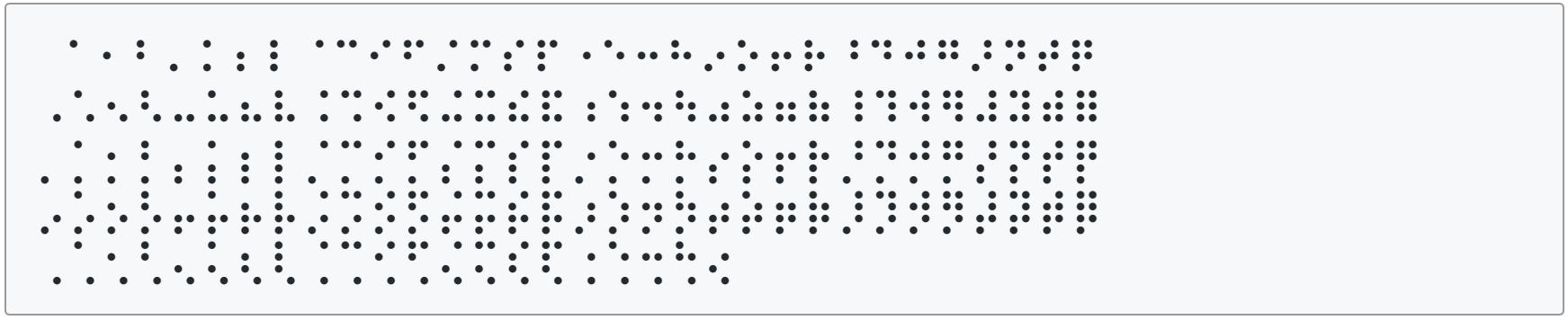
```
> 1 + 1;
← 2

> 1 + 1;
← 🚑 SyntaxError: illegal character 🚑
```

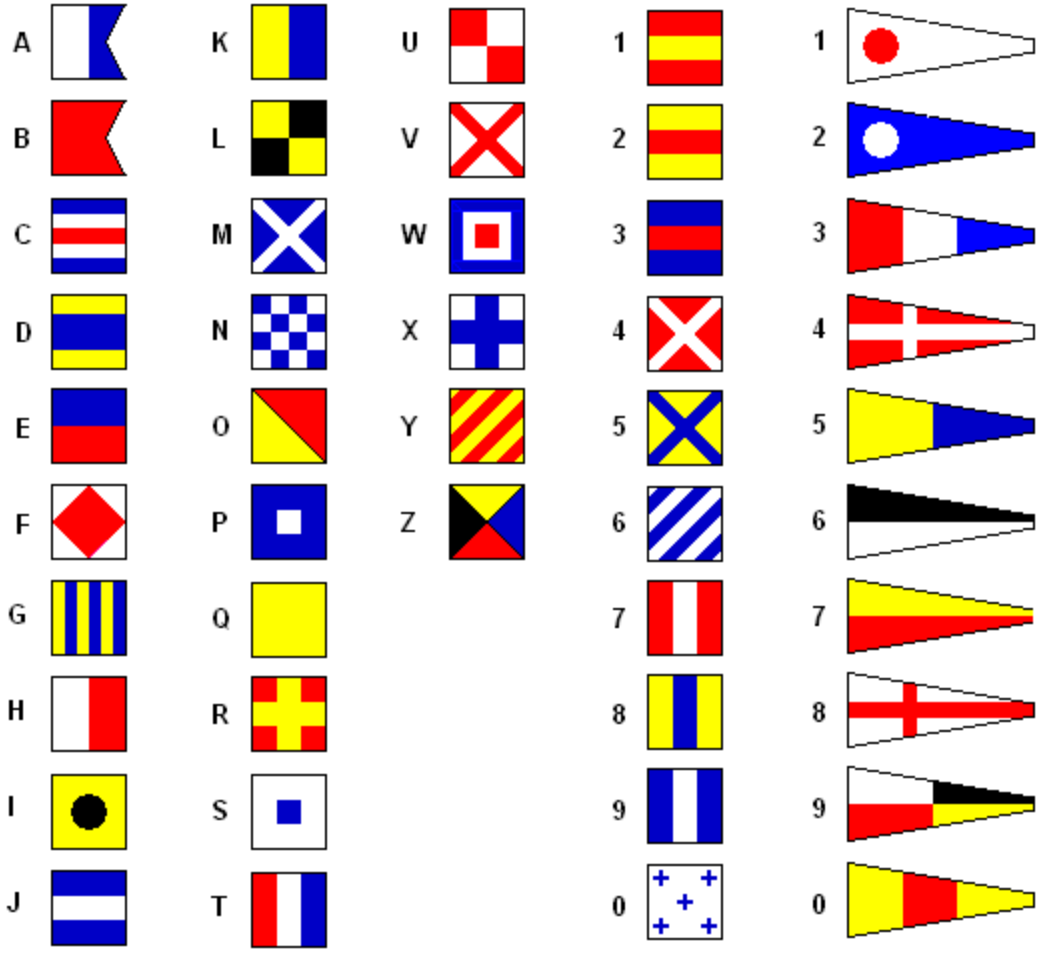
Encodings

not encryption

Braille



“Ancient” encodings



Maritime Signal Flags

Penants

“Ancient” encodings — Morse

```
M   O   R   S  E           C    O   D  E
-- --- .-. ... . (space) -.-. --- -.. .
```

- Three letters: $\{\_, ., EOW\}$
- Variable-width letters

一 丨 丶 丿 乙 亅 二 亠

〇〇〇三 七	〇〇二三 中	〇〇四三 [illegible]	〇〇六三 予	〇〇八三 亢	〇一〇三 仃	〇一二三 仰	〇一四三 休	〇一六三 低	〇一八三 併
〇〇〇四 丈	〇〇二四 丰	〇〇四四 乏	〇〇六四 事	〇〇八四 交	〇一〇四 仆	〇一二四 伃	〇一四四 伙	〇一六四 住	〇一八四 佶
〇〇〇五 三	〇〇二五 串	〇〇四五 乖	〇〇六五	〇〇八五 亥	〇一〇五 仇	〇一二五 伶	〇一四五 伯	〇一六五 佐	〇一八五 佾
〇〇〇六 上	〇〇二六	〇〇四六 乘	〇〇六六	〇〇八六 亦	〇一〇六 今	〇一二六 仲	〇一四六 估	〇一六六 佑	〇一八六 使
〇〇〇七 下	〇〇二七	〇〇四七	〇〇六七 二	〇〇八七 享	〇一〇七 介	〇一二七 伙	〇一四七 佚	〇一六七 佔	〇一八七 侃
〇〇〇八 不	〇〇二八 丶	〇〇四八	〇〇六八 于	〇〇八八 [illegible]	〇一〇八 仍	〇一二八 仳	〇一四八 你	〇一六八 何	〇一八八 來
〇〇〇九 丏	〇〇二九 丸	〇〇四九	〇〇六九 云	〇〇八九 亨	〇一〇九 仔	〇一二九 仵	〇一四九 伲	〇一六九 佗	〇一八九 侈
〇〇一〇 丑	〇〇三〇 凡	〇〇五〇 乙	〇〇七〇 互	〇〇九〇 京	〇一一〇 仕	〇一三〇 件	〇一五〇 伴	〇一七〇 佘	〇一九〇 例
〇〇一一 且	〇〇三一 丹	〇〇五一 九	〇〇七一 五	〇〇九一 亭	〇一一一 他	〇一三一 攸	〇一五一 佮	〇一七一 余	〇一九一 侍
〇〇一二 丕	〇〇三二 主	〇〇五二 乞	〇〇七二 井	〇〇九二 亮	〇一一二 仗	〇一三二 价	〇一五二 伸	〇一七二 佛	〇一九二 侏
〇〇一三 世	〇〇三三	〇〇五三 也	〇〇七三 亘	〇〇九三 亳	〇一一三 付	〇一三三 任	〇一五三 伺	〇一七三 作	〇一九三 侐
〇〇一四 丘	〇〇三四	〇〇五四 乩	〇〇七四 亙	〇〇九四 亶	〇一一四 仙	〇一三四 仿	〇一五四 伻	〇一七四 佞	〇一九四 侑
〇〇一五 丙	〇〇三五 丿	〇〇五五 乳	〇〇七五 況	〇〇九五 亹	〇一一五 仝	〇一三五 企	〇一五五 似	〇一七五 佟	〇一九五 侔
〇〇一六 丞	〇〇三六 乂	〇〇五六 乾	〇〇七六 些	〇〇九六	〇一一六 仞	〇一三六 伉	〇一五六 伽	〇一七六 佩	〇一九六 侖
〇〇一七 [illegible]	〇〇三七 [illegible]	〇〇五七 [illegible]	〇〇七七 [illegible]	〇〇九七	〇一一七 [illegible]	〇一三七 [illegible]	〇一五七 [illegible]	〇一七七 [illegible]	〇一九七 [illegible]

“Ancient” encodings — Chinese telegraph code

```
電   碼

7193 4316
--... .---- ----. ...-- / ....- ...-- .---- -....

EGL  EWS
. --. .-.. / . .-- ...
```

- Same characters, different encodings, different lengths
- The ***code point*** (電 = 7193) is not the ***encoding*** (morse)

ASCII

```
00 NUL    20        40 @    60 `
01 SOH    21 !      41 A    61 a
02 STX    22 "      42 B    62 b
03 ETX    23 #      43 C    63 c
04 EOT    24 $      44 D    64 d
05 ENQ    25 %      45 E    65 e
06 ACK    26 &      46 F    66 f
07 BEL    27 '      47 G    67 g
08 BS     28 (      48 H    68 h
09 HT     29 )      49 I    69 i
0A LF     2A *      4A J    6A j
0B VT     2B +      4B K    6B k
0C FF     2C ,      4C L    6C l
0D CR     2D -      4D M    6D m
0E SO     2E .      4E N    6E n
0F SI     2F /      4F O    6F o
⋮         ⋮         ⋮        ⋮
```

http://www.catb.org/esr/faqs/things-every-hacker-once-knew/

https://youtu.be/MikoF6KZjm0?t=289

ASCII

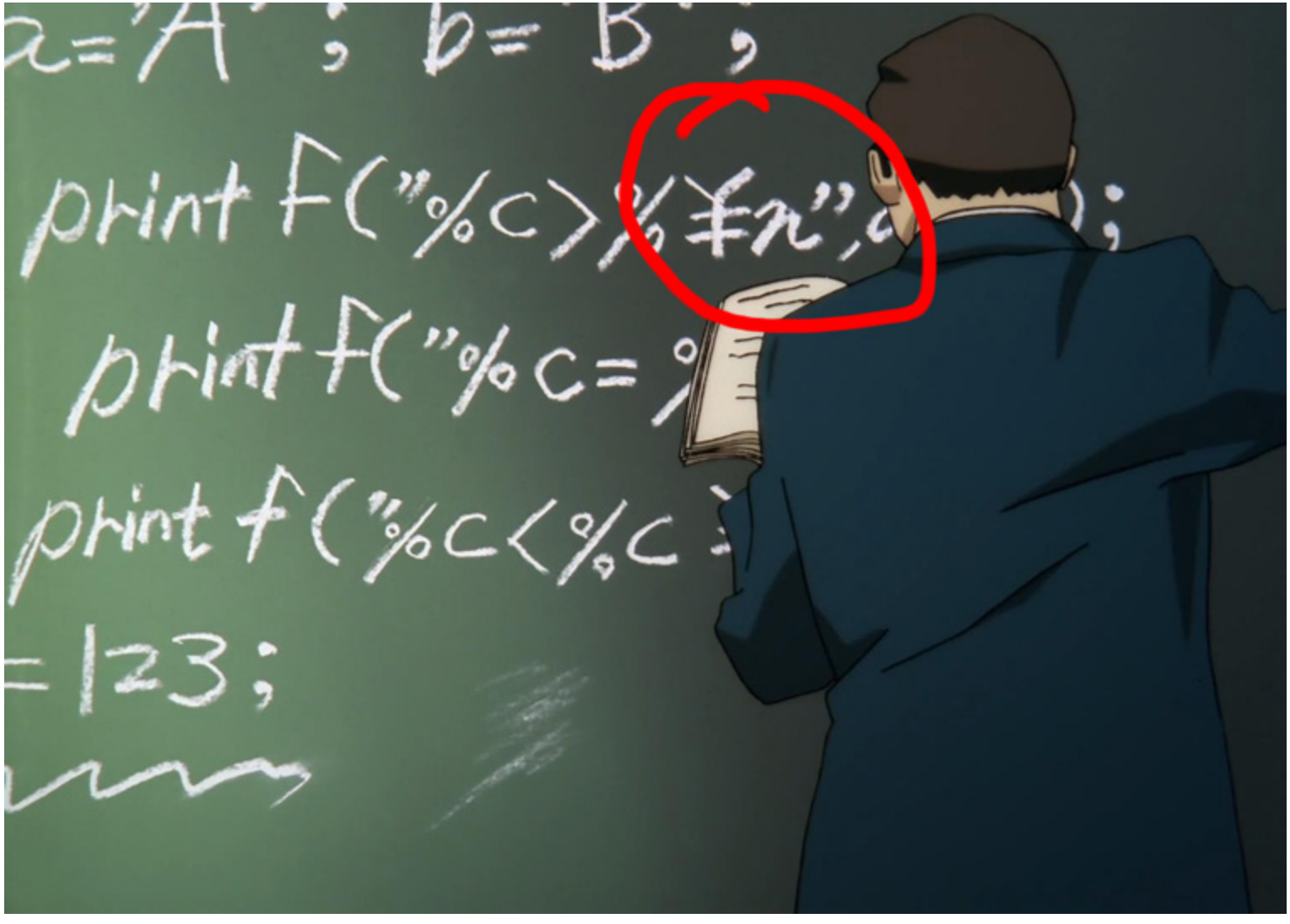
- 1963
- American Standard Code for Information Interchange
- 7-bit (8^{th} bit used for parity)
- $2^7 = 128$ possible values
- Has a method to its madness!

ASCII

- 0–31 are control characters `NUL` `CR` `LF` `DEL`
- 32–126 are punctuation, numerals and letters
- `␣` in binary: `0100000` $= 32 =$ 0x20
- `A` in binary: `1000001` $= 65 =$ 0x41
- `a` in binary: `1100001` $= 97 =$ 0x61
  - $= 65 + 32$
  - $=$ 0x41 $+$ 0x20
  - $=$ `1000001 | 0100000`

Modified ASCII

- Extended ASCII (8-bit, has more characters `ç` `ü` `▒` `¶` `æ`)
- Modified 7-bit ASCII exist
  - `#` → `£` on UK teletypes
  - `\` → `¥` in Japan (Shift-JIS)
  - `\` → `₩` in Korea (EUC-KR)


a='A'; b= B';
print f("%c)%¥n",a);
print f("%c=%
print f("%c<%c
=123;

ASCII Highlights

Control characters

- `CR` Moves the print head to the left margin
- `LF` Scrolls down one line
- `DEL` Backspace and delete
- `ETX` `^C` (SIGINT)
- `EOT` `^D`
- `BEL` Rings the (physical) bell

```
sleep 3 && echo $'\a'
```

ASCII ⇔ Unix/Linux *control* codes

Hex	Char	Hex	Char
00	NUL '\0' (null character)	40	@
01	SOH (start of heading)	41	A
02	STX (start of text)	42	B
03	ETX (end of text)	43	C 👈
04	EOT (end of transmission)	44	D 👈
05	ENQ (enquiry)	45	E
06	ACK (acknowledge)	46	F
07	BEL '\a' (bell)	47	G
08	BS '\b' (backspace)	48	H 👈
09	HT '\t' (horizontal tab)	49	I
⋮			

```
man ascii
```

So, what's the problem with ASCII?

```
ASCII
^
```

Problems with ASCII

- Latin-centric
- Everybody else came up with their own encodings
- Alternative ASCII sets cause problems with interchange
- Mojibake (文字化け; moji bake): JIS, Shift-JIS, EUC, and Unicode
- No emoji, only emoticons :-(

Dark ages

- ???
- ???
- ???
- ???
- ???
- Xerox Character Code Standard (XCCS), 1980

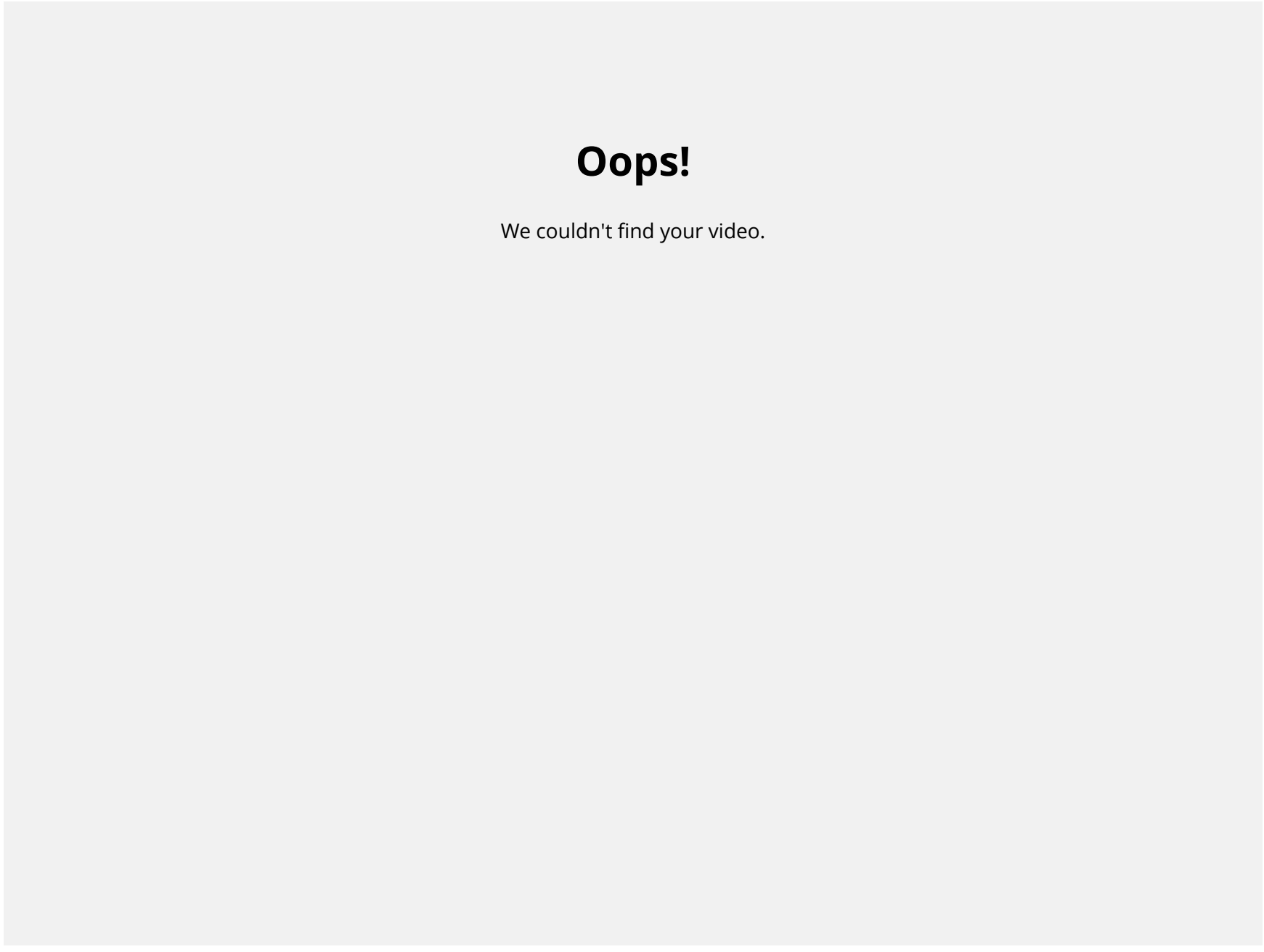
Early telecommunications	ASCII · ISO/IEC 646 · ISO/IEC 6937 · T.61 · BCDIC · Baudot code · Morse code (Telegraph code Wabun code) · Special telegraphy codes: Non-Latin, Chinese, Cyrillic · Needle telegraph codes
ISO/IEC 8859	-1 · -2 · -3 · -4 · -5 · -6 · -7 · -8 · -9 · -10 · -11 · -12 · -13 · -14 · -15 · -16
Bibliographic use	ANSEL · ISO 5426 / 5426-2 / 5427 / 5428 / 6438 / 6861 / 6862 / 10585 / 10586 / 10754 / 11822 · MARC-8
National standards	ArmSCII · BraSCII · CNS 11643 · ELOT 927 · GOST 10859 · GB 18030 · HKSCS · ISCII · JIS X 0201 · JIS X 0208 · JIS X 0212 · JIS X 0213 · KOI-7 · KPS 9566 · KS X 1001 · PASCII · SI 960 · TIS-620 · TSCII · VISCII · YUSCII
EUC	CN · JP · KR · TW
ISO/IEC 2022	CN · JP · KR · CCCII
MacOS code pages ("scripts")	Arabic · Celtic · CentEuro · ChineseSimp / EUC-CN · ChineseTrad / Big5 · Croatian · Cyrillic · Devanagari · Dingbats · Esperanto · Farsi · Gaelic · Greek · Gujarati · Gurmukhi · Hebrew · Iceland · Japanese / ShiftJIS · Korean / EUC-KR · Latin-1 · Roman · Romanian · Sámi · Symbol · Thai / TIS-620 · Turkish · Ukrainian
DOS code pages	100 · 111 · 112 · 113 · 151 · 152 · 161 · 162 · 163 · 164 · 165 · 166 · 210 · 220 · 301 · 437 · 449 · 489 · 620 · 667 · 668 · 707 · 708 · 709 · 710 · 711 · 714 · 715 · 720 · 721 · 737 · 768 · 770 · 771 · 772 · 773 · 774 · 775 · 776 · 777 · 778 · 790 · 850 · 851 · 852 · 853 · 854 · 855/872 · 856 · 857 · 858 · 859 · 860 · 861 · 862 · 863 · 864/17248 · 865 · 866/808 · 867 · 868 · 869 · 874/1161/1162 · 876 · 877 · 878 · 881 · 882 · 883 · 884 · 885 · 891 · 895 · 896 · 897 · 898 · 899 · 900 · 903 · 904 · 906 · 907 · 909 · 910 · 911 · 926 · 927 · 928 · 929 · 932 · 934 · 936 · 938 · 941 · 942 · 943 · 944 · 946 · 947 · 948 · 949 · 950/1370 · 951 · 966 · 991 · 1034 · 1039 · 1040 · 1041 · 1042 · 1043 · 1044 · 1046 · 1086 · 1088 · 1092 · 1093 · 1098 · 1108 · 1109 · 1114 · 1115 · 1116 · 1117 · 1118 · 1119 · 1125/848 · 1126 · 1127 · 1131/849 · 1139 · 1167 · 1168 · 1300 · 1351 · 1361 · 1362 · 1363 · 1372 · 1373 · 1374 · 1375 · 1380 · 1381 · 1385 · 1386 · 1391 · 1392 · 1393 · 1394 · Kamenický · Mazovia · CWI-2 · KOI8 · MIK · Iran System
IBM AIX code pages	367 · 371 · 806 · 813 · 819 · 895 · 896 · 912 · 913 · 914 · 915 · 916 · 919 · 920 · 921/901 · 922/902 · 923 · 952 · 953 · 954 · 955 · 956 · 957 · 958 · 959 · 960 · 961 · 963 · 964 · 965 · 970 · 971 · 1004 · 1006 · 1008 · 1009 · 1010 · 1011 · 1012 · 1013 · 1014 · 1015 · 1016 · 1017 · 1018 · 1019 · 1029 · 1036 · 1089 · 1111 · 1124 · 1129/1163 · 1133 · 1350 · 1382 · 1383
IBM Apple Macintosh Emulations	1275 · 1280 · 1281 · 1282 · 1283 · 1284 · 1285 · 1286
IBM Adobe Emulations	1038 · 1276 · 1277
IBM DEC Emulations	1020 · 1021 · 1023 · 1090 · 1100 · 1101 · 1102 · 1103 · 1104 · 1105 · 1106 · 1107 · 1287 · 1288
IBM HP Emulations	1050 · 1051 · 1052 · 1053 · 1054 · 1055 · 1056 · 1057 · 1058
Windows code pages	CER-GS · 874/1162 (TIS-620) · 932/943 (Shift JIS) · 936/1386 (GBK) · 950/1370 (Big5) · 949/1363 (EUC-KR) · 1169 · 1174 · Extended Latin-8 · 1200 (UTF-16LE) · 1201 (UTF-16BE) · 1250 · 1251 · 1252 · 1253 · 1254 · 1255 · 1256 · 1257 · 1258 · 1259 · 1261 · 1270 · 54936 (GB18030)
EBCDIC code pages	1 · 2 · 3 · 4 · 5 · 6 · 7 · 8 · 9 · 10 · 11 · 12 · 13 · 14 · 15 · 16 · 17 · 18 · 19 · 20 · 21 · 22 · 23 · 24 · 25 · 26 · 27 · 28 · 29 · 30 · 31 · 32 · 33 · 34 · 35 · 36 · 37/1140 · 38 · 39 · 40 · 251 · 252 · 254 · 256 · 257 · 258 · 259 · 260 · 264 · 273/1141 · 274 · 275 · 276 · 277/1142 · 278/1143 · 279 · 280/1144 · 281 · 282 · 283 · 284/1145 · 285/1146 · 286 · 287 · 288 · 289 · 290 · 293 · 297/1147 · 298 · 300 · 310 · 320 · 321 · 322 · 330 · 351 · 352 · 353 · 355 · 357 · 358 · 359 · 360 · 361 · 363 · 382 · 383 · 384 · 385 · 386 · 387 · 388 · 389 · 390 · 391 · 392 · 393 · 394 · 395 · 410 · 420/16804 · 421 · 423 · 424/8616/12712 · 425 · 435 · 500/1148 · 803 · 829 · 833 · 834 · 835 · 836 · 837 · 838/838 · 839 · 870/1110/1153 · 871/1149 · 875/4971/9067 · 880 · 881 · 882 · 883 · 884 · 885 · 886 · 887 · 888 · 889 · 890 · 892 · 893 · 905 · 918 · 924 · 930/1390 · 931 · 933/1364 · 935/1388 · 937/1371 · 939/1399 · 1001 · 1002 · 1003 · 1005 · 1007 · 1024 · 1025/1154 · 1026/1155 · 1027 · 1028 · 1030 · 1031 · 1032 · 1033 · 1037 · 1047 · 1068 · 1069 · 1070 · 1071 · 1073 · 1074 · 1075 · 1076 · 1077 · 1078 · 1079 · 1080 · 1081 · 1082 · 1083 · 1084 · 1085 · 1087 · 1091 · 1097 · 1112/1156 · 1113 · 1122/1157 · 1123/1158 · 1130/1164 · 1132 · 1136 · 1137 · 1150 · 1151 · 1152 · 1159 · 1165 · 1166 · 1278 · 1279 · 1303 · 1364 · 1376 · 1377 · JEF · KEIS
Platform specific	Acorn · Adobe Standard · ATASCII · Atari ST · BICS · Casio calculators · CDC · CPC · DEC Radix-50 · DEC MCS/NRCS · DG International · ELWRO-Junior · FIELDATA · GEM · GEOS · GSM 03.38 · HP Roman Extension · HP Roman-8 · HP Roman-9 · HP calculators · LICS · LMBCS · NEC APC · NeXT · PETSCII · Sharp calculators · TI calculators · Ventura International · Ventura Symbol · WISCII · XCCS · ZX80 · ZX81 · ZX Spectrum
Unicode / ISO/IEC 10646	UTF-1 · UTF-7 · UTF-8 · UTF-16 (UTF-16LE/UTF-16BE) / UCS-2 · UTF-32 (UTF-32LE/UTF-32BE) / UCS-4 · UTF-EBCDIC · GB 18030 · BOCU-1 · CESU-8 · SCSU
Miscellaneous code pages	ABICOMP · APL · Cork · HZ · Johab · SEASCII · TACE16 · TRON · UTF-5 · UTF-6 · WTF-8
Related topics	Code page · Control character (C0 C1) · CCSID · Character encodings in HTML · Charset detection · Han unification · Hardware · ISO 6429/IEC 6429/ANSI X3.64 · Mojibake

Unicode

Timeline of Unicode

- 1985, Sapporo, 🇯🇵
- KanjiTalk, localised 🍎
- Shift-JIS is a 💩
- Bunch of 👷 start working on Unicode specs
- 1988, submitted to ISO 📰
- 1991, Han Unification accepted 🤔
- 1992, 👋 *Kiss Your ASCII Goodbye* in *PC Magazine*
- 1995, ☕ Java 1.0 launches with Unicode support

http://www.unicode.org/history/earlyyears.html

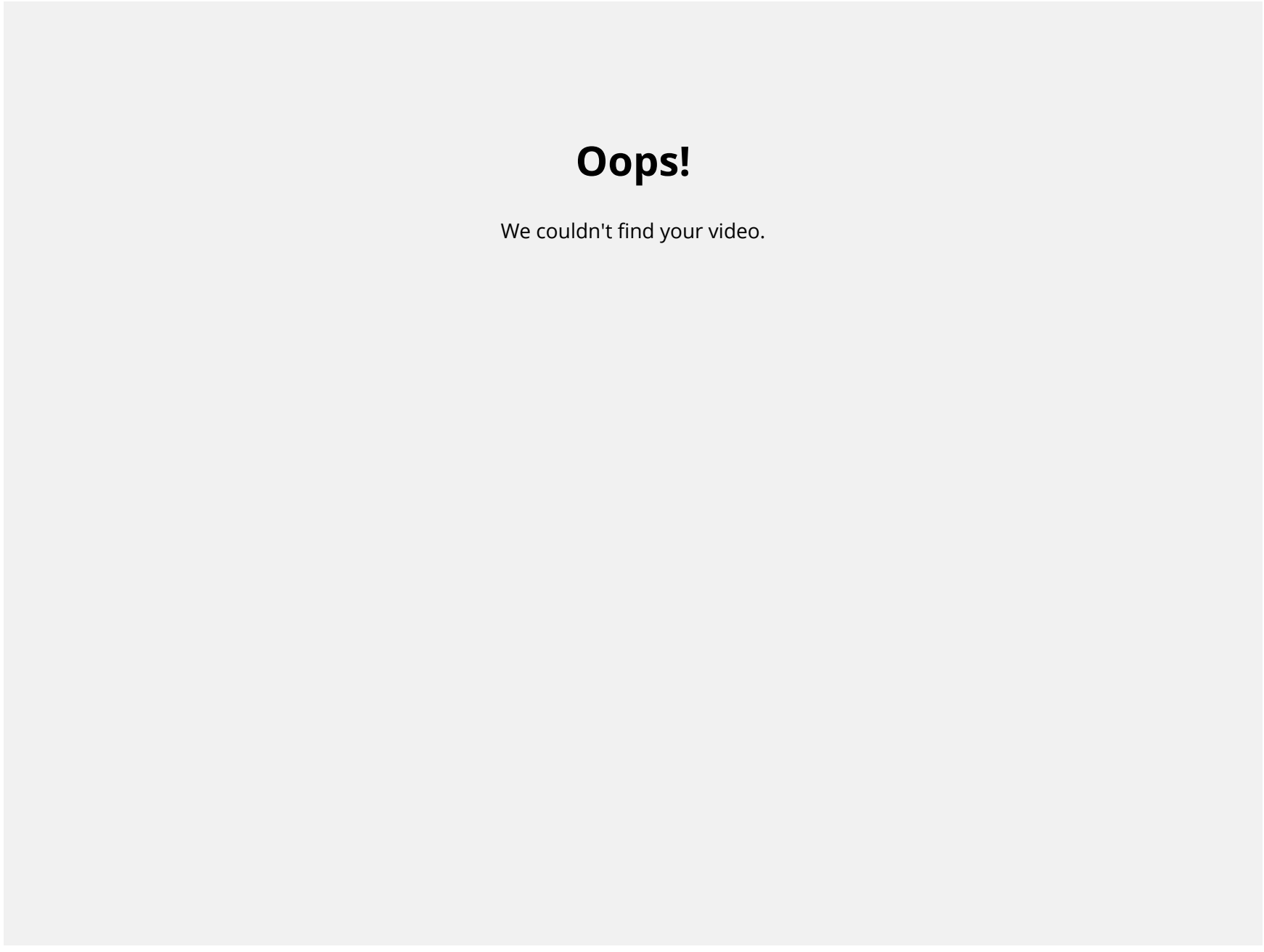


The first Unicode TV interview (1991)

http://www.unicode.org/history/unicodeMOV.mov

In that video, the VP of Unicode made:

- three statements
- three inaccuracies (in 2017)



Unicode: the Movie (2000)

http://www.unicode.org/history/movie/UniMovie-large.mov

Unicode features*

- A common representation for all characters
- $\simeq$ Compatible with ASCII for English (`A` $= 65$)
- Efficient encoding
- ~~Uniform width encoding~~
- Han unification (CJK languages share glyphs)

Unicode 10.0 (2017 June 20)

> Unicode 10.0 adds 8,518 characters, for a total of 136,690 characters

http://www.unicode.org/versions/Unicode10.0.0/

> 56 emoji (2,666 total)

http://www.unicode.org/reports/tr51/tr51-12.html#Emoji_Counts

> Bitcoin sign

...and more

Unicode terminology

- Scalar value `€ U+20AC EURO SIGN`
- Range `U+0000..U+FFFF`
- Sequence `É <U+0045 LATIN CAPITAL LETTER E, U+0301 COMBINING ACUTE ACCENT>`

Unicode planes

- `U+0000..U+FFFF` is Plane 0, Basic Multilingual Plane (BMP)
- Each plane encodes up to $2^{16} = 65536$ code points
- Commonly used characters

Standard

Unicode

Encoding

UTF-8, UTF-16, UTF-32, UCS-2, UCS-4

UTF-16

- Early UTF-16 was fixed-width (UCS-2)
- 2 or 4 bytes per character
- 2 bytes for characters in BMP
    - Can be more efficient than UTF-8 for CJK (2B vs 3B)
- Surrogate pairs have to be handled for code points outside BMP
    - Byte-order matters

UTF-32

- 32 bits ought to be enough for anybody

UTF-32

- `A` now takes up 4 bytes

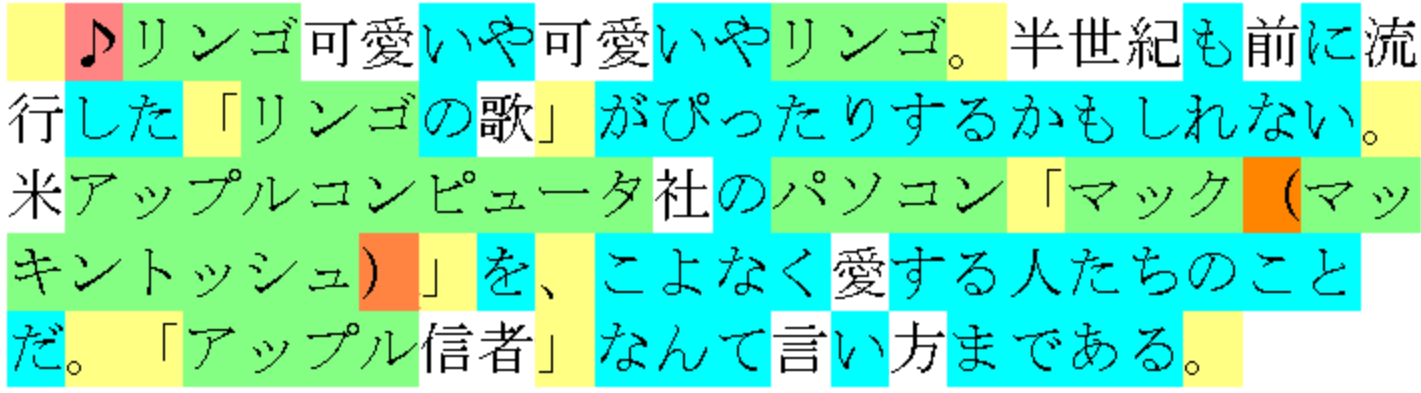
SCSU

But wait! There's more!

Standard Compression Scheme for Unicode

http://www.unicode.org/reports/tr6/

SCSU



= not compressible	18/12 = 1.5
= 3000 - 307F static window 7	12/11 = 1.1
= 3040 - 309F dynamic window 5	45/14 = 4.2
= 30A0 - 30FF dynamic window 6	38/8 = 4.75
= FF00 - FF7F dynamic window 7	2/2 = 1.00
= 2600-267F	1/1 = 1.00

- Do not use it*

UTF-8

- Variable width
- Single-byte (Same as ASCII, 7-bits)

```
00100100
└ Is single-byte
```

= 36 = 0x24 = `$ U+0024 DOLLAR SIGN`

UTF-8

- Multi-byte

```
1110aaaa 10bbbbbb 10cccccc
││└┘      └┤        ├┘
││         └ Is continuation byte
││
│└ 2 continuation bytes
└ Is multi-byte
```

- First byte specifies number of continuation bytes
- Encoded character is `aaaabbbb` `bbcccccc`

Private use areas

- `U+E000..U+F8FF`, `U+F0000..U+FFFFD`, `U+100000..U+10FFFD`
- Suggested for internal use
  - data processing
  - artificial scripts
  - ancient scripts
- □ `U+F8FF` (`⇧` - `⌥` - `k`)
- Ubuntu has `U+E0FF` and `U+F200`

U+E0FF:
U+F200: ubuntu®

Combining characters

- Modify other characters

  `e` + `´` = `é`

  ```
  <e U+0065 LATIN SMALL LETTER E,
  ´U+0301 COMBINING ACUTE ACCENT>
  ```

- Precomposed `é`

  ```
  é U+00E9 LATIN SMALL LETTER E WITH ACUTE
  ```

- Modifiers come after base character

Unicode normalisation

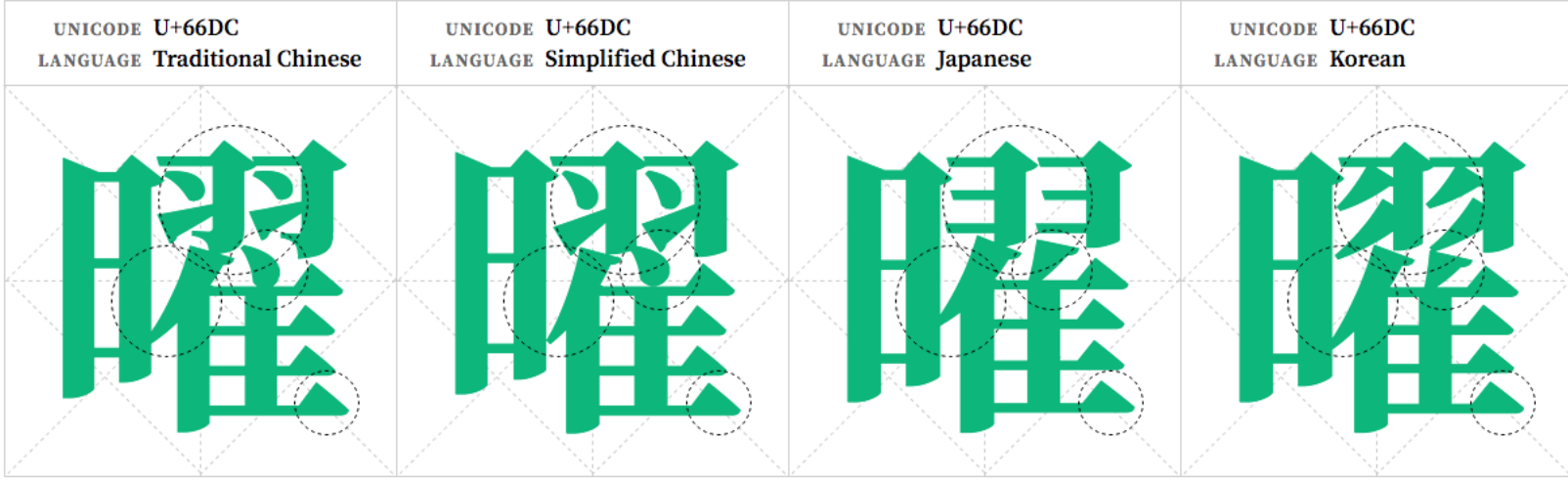
- Some combined characters are sort of the same
- Equivalence criteria
  - canonical (NF)
  - compatibility (NFK)
- `ﬃ` `U+FB03 LATIN SMALL LIGATURE FFI` vs `f` `f` `i`
  - not equivalent under canonical (NF)
  - equivalent under NFK compatiability (NFK)
- NF is used to canonicalise combining characters

Unicode normalisation

- NFD *Normalization Form Canonical Decomposition*
- NFC *Normalization Form Canonical Composition*
- NFKD *Normalization Form Compatibility Decomposition*
- NFKC *Normalization Form Compatibility Composition*

Han unification

- Maps common Chinese, Japanese, Korean (CJK) characters into unified set



- Different countries have different standards

Han unification

- Variants can be significant (names)

  ashi
  芦 Ashi·da, given name vs Ashi·ya, old place name

  芦田さんは芦屋のお嬢様だ

- Educational software
- People get 😠 over the differences

Han unification

> CJK Extension F contains mostly rare characters, but also includes a number of personal and placename characters important for government specifications in Japan, in particular.

CJK Extension F was added in Unicode 10.0 (2017)

Han unification

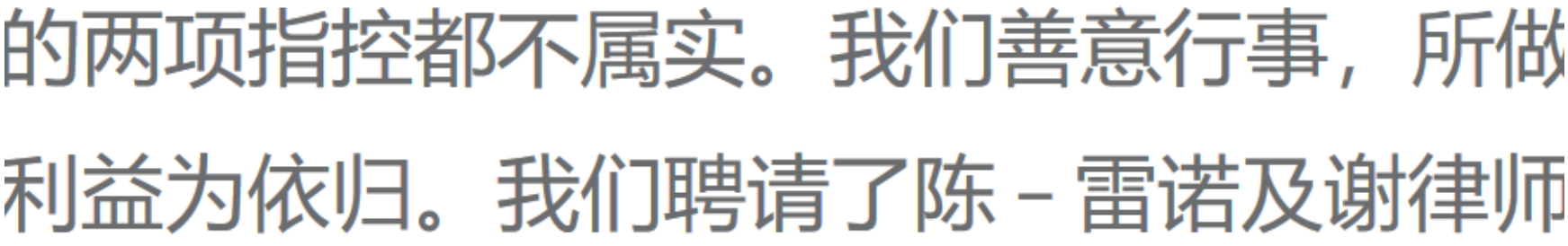
- Lose round-trip conversion compatibility with character sets which have variants

https://support.microsoft.com/en-us/help/170559/prb-conversion-problem-between-shift-jis-and-unicode

Rendering issues

What could possibly go wrong?

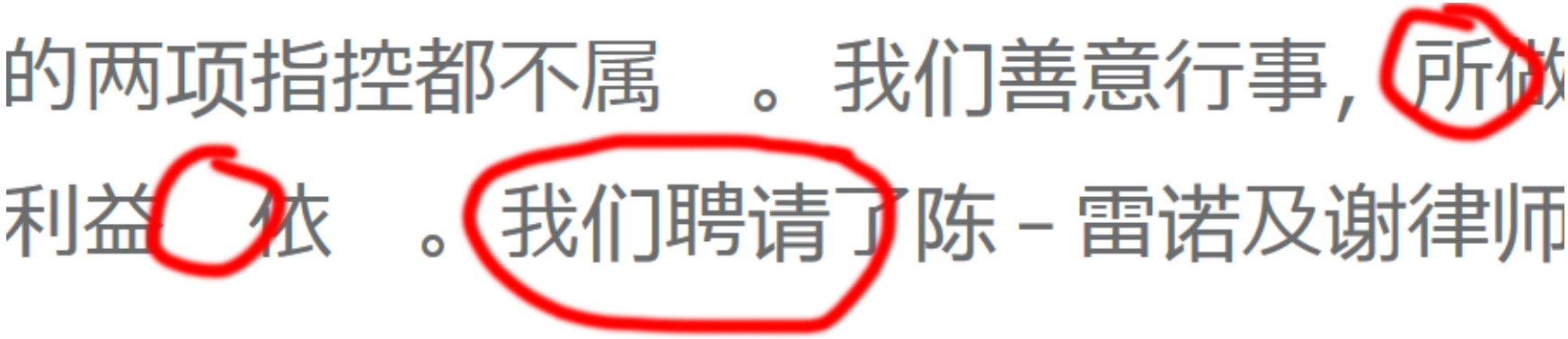
`lang="zh"`



Rendering issues

Blank characters, mixed fonts, wrong glyphs

`lang="en"`



Han unification

- Can use Unicode variation selectors

`U+E0101 VARIATION-SELECTOR-18`

```
>> "刃\ufe04"
<- "刃"
>> "刃\uDB40\uDD01"
<- "刃"
```

http://www.unicode.org/ivd/

http://unicode.org/reports/tr37/

Control sequences and vertical text

- Vertical text
- RTL mark

Unicode Bidirectional Algorithm @ http://unicode.org/reports/tr9/

Unicode Vertical Text Layout @ http://www.unicode.org/reports/tr50/

Ligatures

> Unicode maintains that ligaturing is a presentation issue rather than a character definition issue

- But! There are some predefined ligatures

  `ﬄ U+FB04 LATIN SMALL LIGATURE FFL`

  `𝓐𝓥 U+A738 LATIN CAPITAL LETTER AV`

  `æ U+00E6 LATIN SMALL LETTER AE`

- Similar issue with subscript and superscript

Emoji

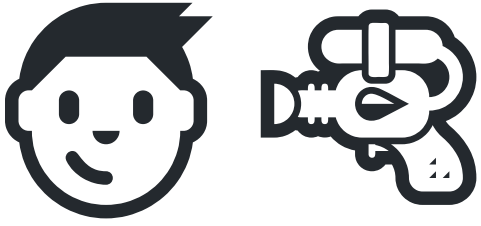
- e moji
- 絵 (≅ picture) ＋ 文字(≅ written character)
- Early emoji were created by Japanese telcos
- 2008: Gmail, iPhone
- 2010: Unicode 6
- 

http://unicode.org/reports/tr51/

Can be represented differently

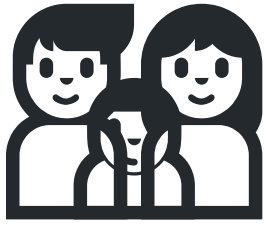
- This is a problem


iOS
Android
Windows
Samsung
LG
HTC
Facebook
Twitter



https://blog.emojipedia.org/google-updates-gun-emoji/

Combining emoji



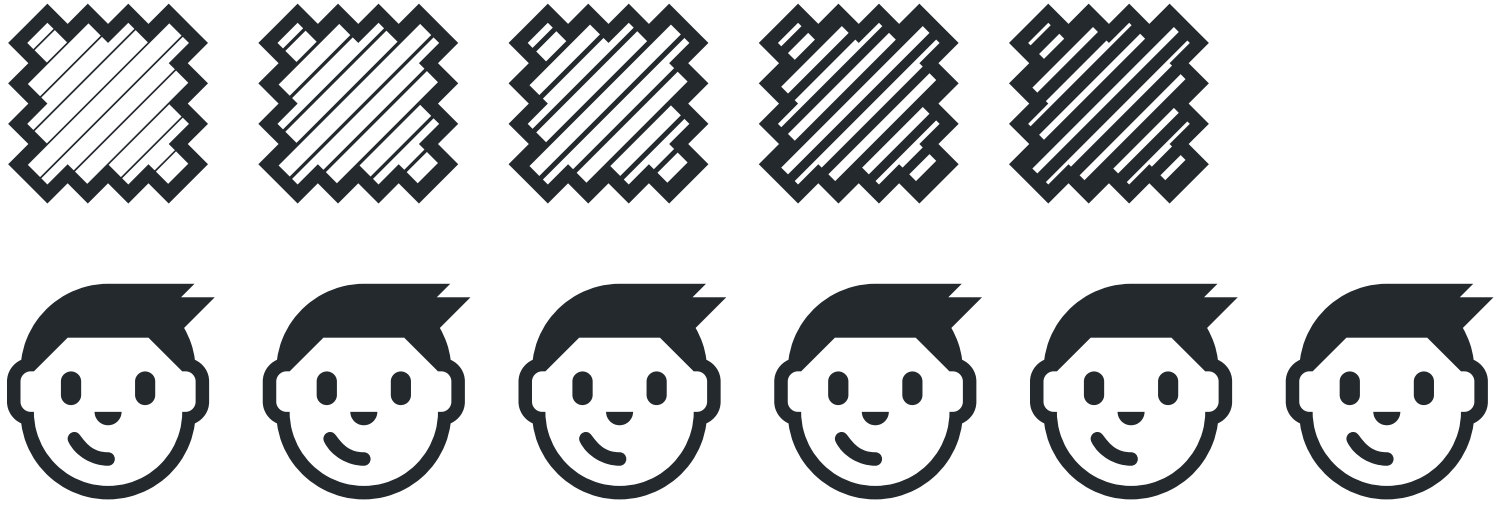
`U+1F46A FAMILY` vs combined character

S + G = SG

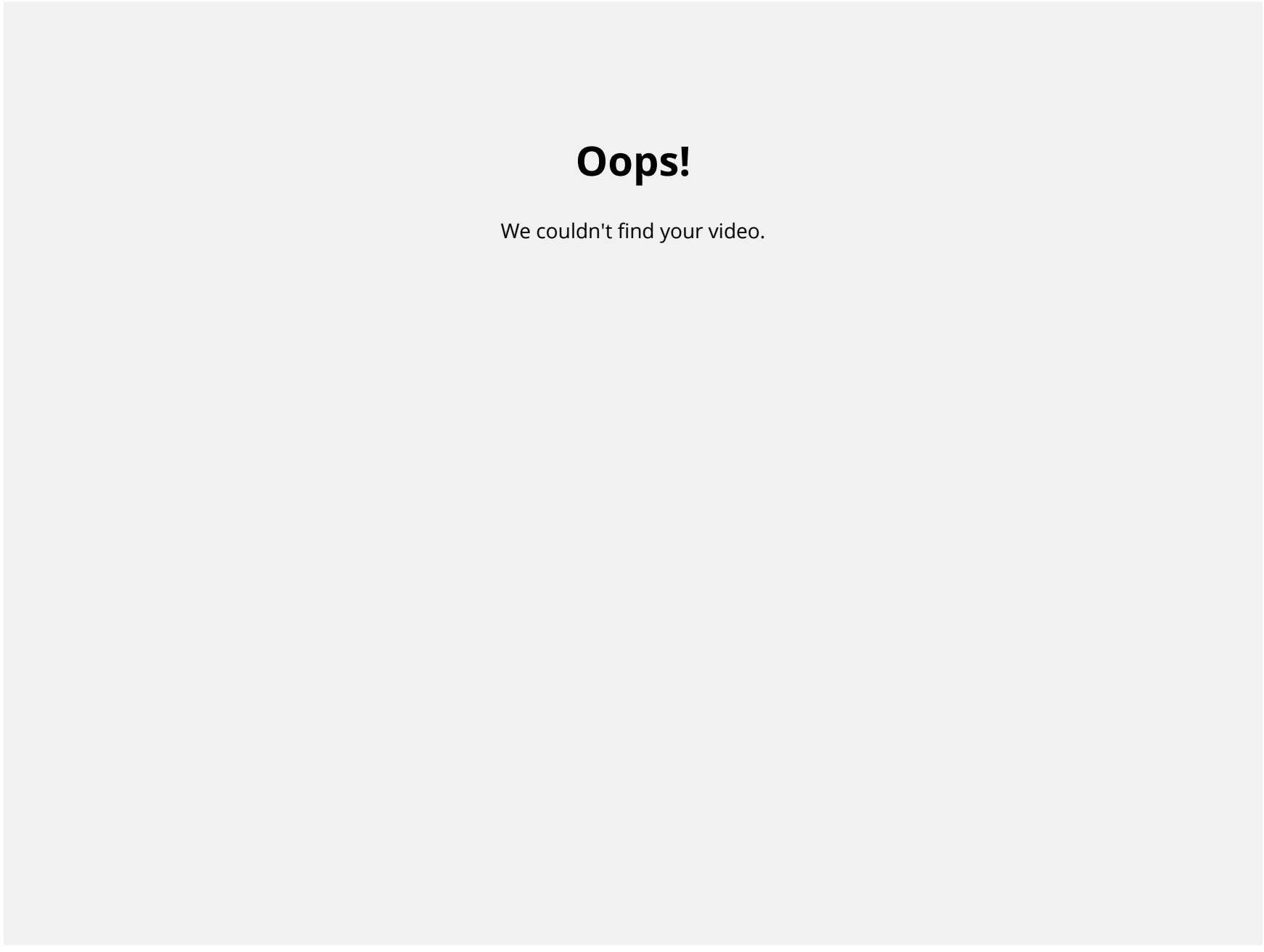
G + S = GS

```
s < U+1F1F8 REGIONAL INDICATOR SYMBOL LETTER S >
g < U+1F1EC REGIONAL INDICATOR SYMBOL LETTER G >
```

Variation selectors



http://unicode.org/faq/vs.html



EarthWeb commercial, 2001

http://www.unicode.org/history/EarthwebCommercial.avi

Necessary

but not necessarily sufficient

programmer knowledge

Recognise garbled text as mojibake

- Maybe able to recover content by swapping character sets
- UTF-8 seen using KOI8-R, a Cyrillic character set

```
п  я─п╟п╨п╬п╥я ▌п╟я─я■
```

UTF-8

```
Библиотека
```

Use UTF-8 for all source code

- Configure your text editor
- Magic comments for some languages

💎 Ruby ≤ 1.9.x

```
# encoding: UTF-8
```

🐍² Python 2

```
# -*- coding: utf-8 -*-
```

💾 C ≤ C99

```
/* Dear future programmer: Good luck 👍 */
```

Text processing

- Treat input as bytes
- Treat text as strings (and not byte arrays)
- Use UTF-8 wherever possible
  - unless you know what you are doing
- Decide what to do with invalid bytes
  - discard or substitute?
- Do not self-roll your own text encoding library

Read in text with the right encoding

Especially when parsing HTML or XML

```
# Nokogiri
doc = Nokogiri.XML(html, nil, 'EUC-JP')
```

```
# Beautiful Soup
soup = BeautifulSoup(html, fromEncoding='Shift_JIS')
```

Set HTML `charset`

```
<!doctype html>
<html>
  <head>
    <meta charset="UTF-8">
  </head>
</html>
```

Use `lang` in HTML as needed

```
<html lang="en">
  <body>
    <span lang="zh-Hans">刃</span>
    <span lang="zh-Hant">刃</span>
    <span lang="ja">刃</span>
    <span lang="ko">刃</span>
    <span lang="vi">刃</span>
  </body>
</html>
```

U+5203	刃	刃	刃	刃	刃	knife edge

Case conversion

- What is the uppercase form of `i`?

Case conversion

- What is the uppercase form of `i`? `I`
- In Turkish?

Case conversion

- What is the uppercase form of `i`?
- In Turkish?

  `ı` → `I`

  `i` → `İ`

Case conversion

- What is the uppercase form of `i`?
- In Turkish?

  `ı` → `I`

  `i` → `İ`
- In Turkish/English mixed text?

Case conversion

- Harder than you think
- What is the uppercase form of `ß U+00DF LATIN SMALL LETTER SHARP S`?

Case conversion

- DE German
- `ß` upcases to `SS`

Case conversion

- `ß` upcases to `SS`
- ...or `U+1E9E ß LATIN CAPITAL LETTER SHARP S`

http://unicode.org/faq/casemap_charprop.html

Case conversion

> In 2016, the Council for German Orthography proposed the introduction of optional use of ß in its ruleset (i.e. variants STRASSE vs. STRAßE would be accepted as equally valid).[9] The rule was officially adopted in 2017.[10]

Does your favourite programming language work?

JavaScript (Firefox 53)

```
>> 'ß'.toLocaleUpperCase('de-DE');
'ß'
```

JavaScript (Chrome 59)

```
>> 'ß'.toLocaleUpperCase('de-DE');
'SS'
```

Does your favourite programming language work?

Python 2

```
>>> u'ß'.upper()
u'\xdf' # ß
```

Python 3

```
>>> 'ß'.upper()
'SS'
```

Does your favourite programming language work?

Ruby 2.3

```
> "\u{00df}".upcase
=> "ß"
```

Ruby 2.4

```
> "\u{00df}".upcase
=> "SS"
```

Does your favourite programming language work?

Java

```
public class UppercaseThis {
    public static void main(String[] args) {
        System.out.println("\u00df".toUpperCase());
    }
}

SS
```

Rust

```
fn main() { println!("{}", "ß".to_uppercase()); }

SS
```

Use variation selectors as needed

`U+E0101 VARIATION-SELECTOR-18`

```
>>  "刃\ufe04"
<-  "刃"
>>  "刃\uDB40\uDD01"
<-  "刃"
```

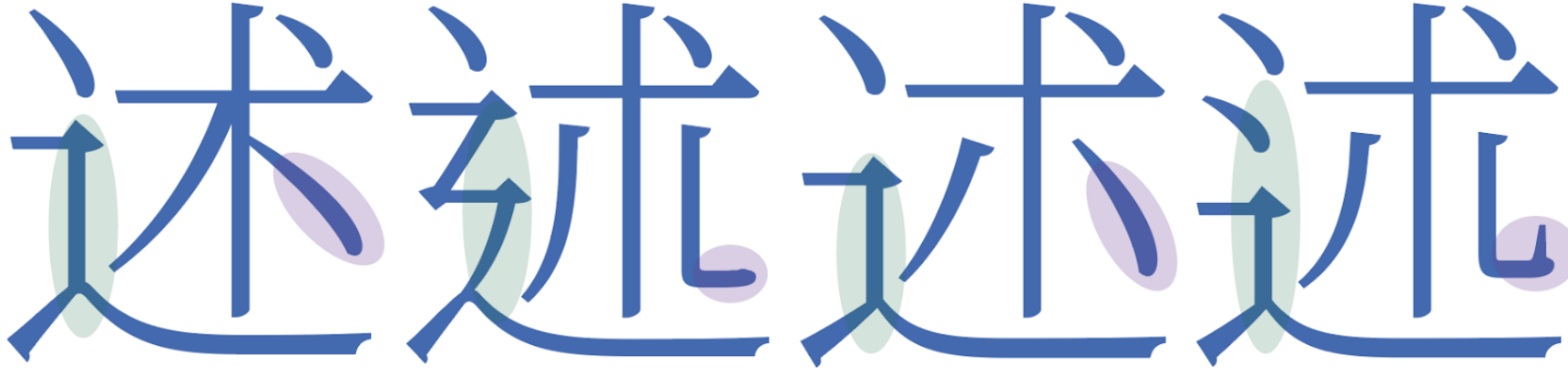
Use a correct font for the language outside HTML

- Google's Noto/Noto CJK has great support
- Similarly, Adobe's Source Han

https://www.google.com/get/noto/help/cjk/
https://source.typekit.com/source-han-serif

Use a correct font for the language outside HTML

Glyph variations



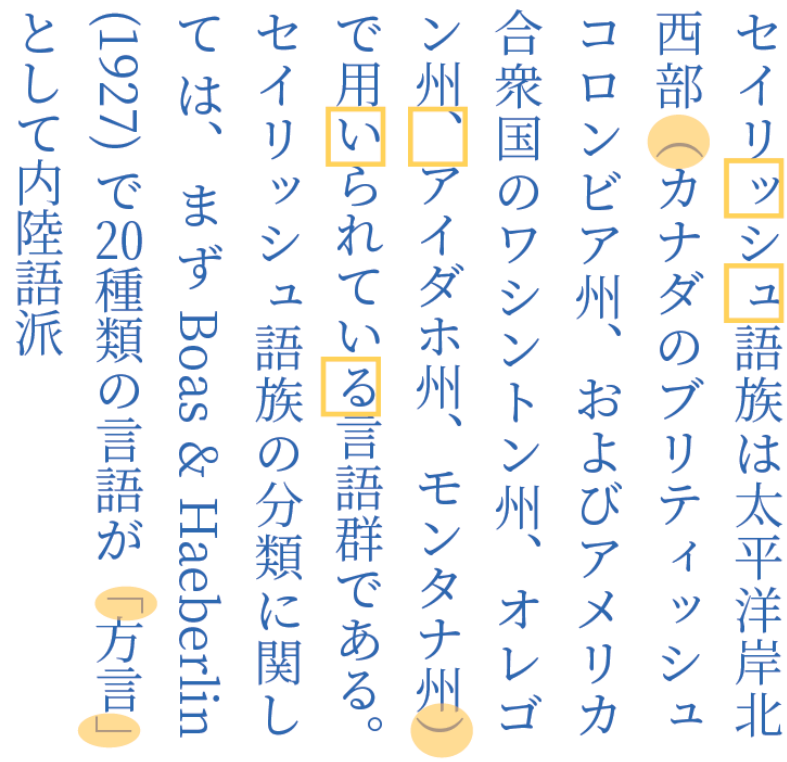
`述 U+8FF0` in S. Chinese, T. Chinese, Japanese and Korean

Noto Serif CJK

Use a correct font for the language outside HTML

Vertical text support

セイリッシュ語族は太平洋岸北西部（カナダのブリティッシュコロンビア州、およびアメリカ合衆国のワシントン州、オレゴン州、アイダホ州、モンタナ州）で用いられている言語群である。セイリッシュ語族の分類に関しては、まず Boas & Haeberlin (1927) で 20 種類の言語が「方言」として内陸語派



Noto Serif CJK

https://helpx.adobe.com/photoshop/user-guide.html?topic=/photoshop/morehelp/text.ug.js


Living, Breathing Asia
DBS INNOVATION
DBS ASIA X
THUR
27
JUL
5.30PM
KERS' NIGHT
THE BEST
WORST
ROBOT
メーカーナイト

Unencoded characters

How can I display (CJK/my own) characters not encoded in Unicode?

UTC-00791

UTC-01312

biáng, from *biángbiáng*面, a noodle dish from Shaanxi, China

Coming to a Unicode version soon?

Unencoded characters

- Use an image
- Use Ideographic Description Sequences

  `U+2FF0..U+2FFF`

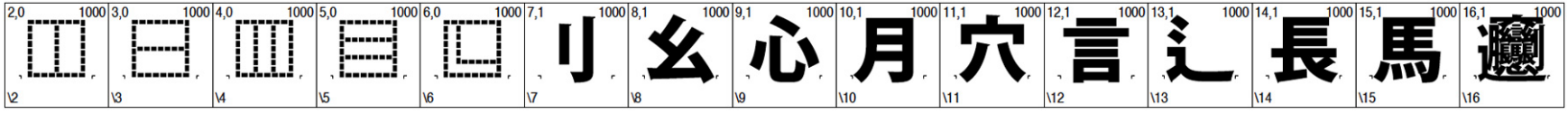
  `書史` for 𣪊
- Use fonts which have the unencoded glyph either
  - as an existing character (Wingdings 🕯👽👓☮)
  - in Private Use Area
  - as a combined sequence

Unencoded characters

- Source Han and Noto have glyphs for *biáng*!
- Uses Unicode and font features to combine existing glyphs
  - Ideographic Description Characters
  - OpenType's `ccmp` (Glyph Composition/Decomposition)
  - Ligatures `liga`

https://blogs.adobe.com/CCJKType/2014/03/ids-opentype.html

Unencoded characters




```
⿴辶⿱穴⿰月⿰⿰⿰幺長⿰言馬⿰幺長 忄心 (traditional)
⿴辶⿱穴⿰月⿰⿰⿰幺长⿰言马⿰幺长 忄心 (simplified)
```

https://blogs.adobe.com/CCJKType/2017/04/designing-implementing-biang.html

What □辶⊟穴皿月⊟皿幺言幺皿長馬長 刂心□辶⊟穴皿月⊟皿幺言幺皿長馬長 刂心面 looks like

String sorting

- Sorting strings is hard!

```
>> 'é' > 'f'
true
```

String sorting

- A-ha! Can we use normalisation for this?

```
>> 'café'.normalize('NFKD')
'cafe ´
```

String sorting

- Sometimes

```
>> '한국어'.normalize('NFKD')
"ㅎ ㅏ ㄴ ㄱ ㅜ ㄱ ㅇ ㅓ"
```

spaces manually added

MDN: String.prototype.normalize()

String sorting and equality

- Use a locale-aware comparison

```
>> ['Aa', 'Äa', 'Äb', 'Ab'].sort();
   ['Aa', 'Ab', 'Äa', 'Äb']
```

```
>> ['Aa', 'Äa', 'Äb', 'Ab']
>>   .sort(a, b => a.localeCompare(b, 'de'));
   ['Aa', 'Äa', 'Ab', 'Äb']
```

MDN: String.prototype.localeCompare()

String searching

- How do I search for `café` by typing `cafe`, or `cafe ́`?

String searching

- Not easy!
- Locale-aware comparisons
- Unicode-aware regex

String searching (proper)

- Read *Unicode Demystified: A Practical Programmer's Guide to the Encoding Standard* by *Richard Gillam*
- Read http://unicode.org/reports/tr10/#Searching

Asymmetric searching

query	matches
resume	resume, Resume, RESUME, résumé, rèsumè, Résumé, …
résumé	résumé, Résumé, RÉSUMÉ, …
けんこ	けんこ, ケンコ, げんこ, けんご, ゲンコ, ケンゴ, …

String length

Problems arise when your string contains

- combining marks
- surrogate pairs (UTF-16)

String length — combined characters

What's the length of `café`?

String length — combined characters

```
>> 'café'.length
5

>> 'café'.normalize().length
4
```

```
>> 'ユニコード'.length
5

>> 'ユニコト\u3099'.normalize().length
5
```

Should generally work for combined characters 

String length — surrogate pairs

What's the length of 💩 `U+1F4A9 PILE OF POO`?

- UTF-8

  `F0 9F 92 A9`

- Surrogate pairs (UTF-16)

  `D83D DCA9`

Does your favourite programming language work?

JavaScript

```
>> '💩'.length
2
>> [...'💩'].length
1
```

Python 2

```
>>> len(u'💩')
2
```

Python 3

```
>>> len('💩')
1
```

Does your favourite programming language work?

Ruby

```
>> '💩'.length
1
```

Java

```
System.out.println("💩".length());
// 2

// This margin is too small to contain the solution
// Use java.text.BreakIterator
```

Rust

```
println!("{}", "💩".len());
// 4

println!("{}", "💩".chars().count());
// 1
```

Regex

- What if you want to match `e` and `é`?
- What about all the different whitespace characters?
- What if I want to match one character `/^.$/` but my character is combined? `é` $\neq$ `e` $+$ `´`
- What about matching non-Latin characters?

Regex

- Use Regex right
- Make sure `\w` `\d` `\s` are Unicode-aware
- Make sure your Regex engine does case-folding
- Match by Unicode (Perl)
  - `\N{}` Named or numbered (Unicode) char or sequence
  - `\o{}` Octal escape sequence.

Regex

- In Perl, you can use `\X`

  > `\X` Unicode "extended grapheme cluster". Not in [].

- You can use Regex ranges with code points
- You might be able to match by Regex classes (Perl, Rust)

```
let re = Regex::new(r"[\p{Greek}]+").unwrap();
```

http://www.unicode.org/reports/tr18/

Emoji

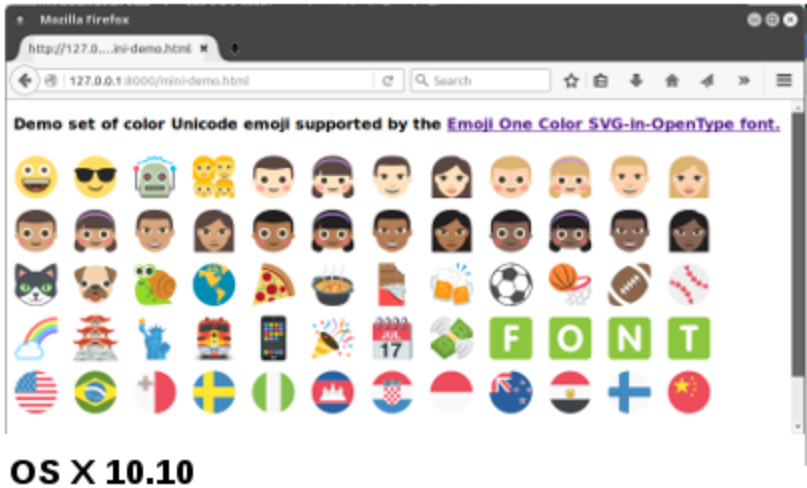
- Combinations or new emoji might not be supported
  - `🤮 U+1F92E FACE VOMITTING` (Emoji 5.0, 2017)
  - `🤷‍♂ <U+1F937 SHRUG, U+2642 MALE>` (Emoji 4.0, 2016)
  - `🐱‍🐉 Ninja Cat riding T-Rex` (Windows 10 only)

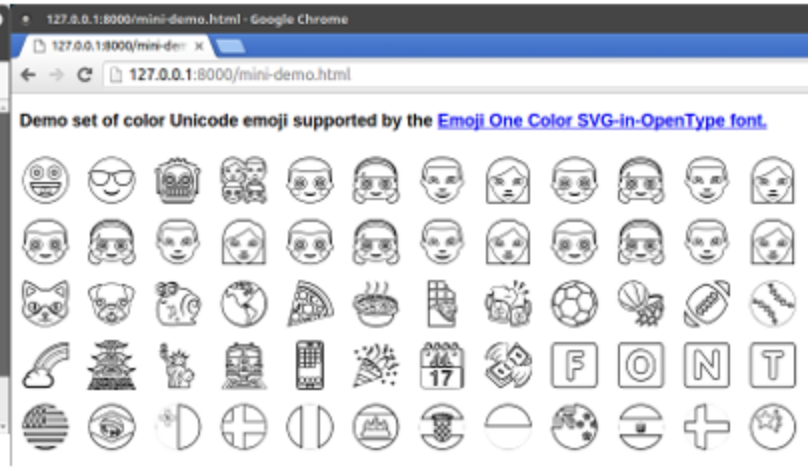
Emoji

- Replace emoji with images (GitHub, Twitter)
  - https://github.com/twitter/twemoji
- Use (coloured) emoji fonts
  - https://github.com/eosrei/emojione-color-font
  - https://github.com/googlei18n/noto-emoji
- Let it be

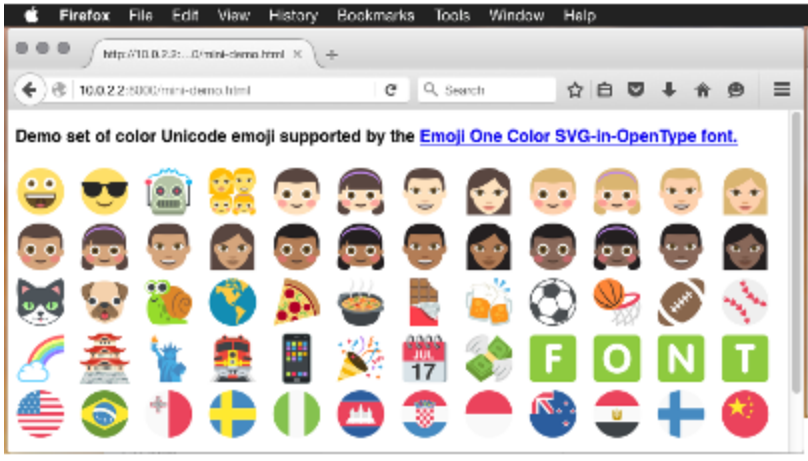
Apple	
Google	
Microsoft	

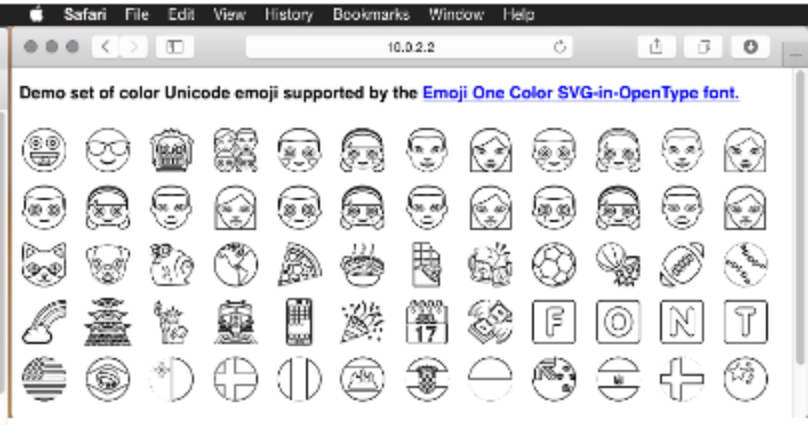
Ubuntu Linux



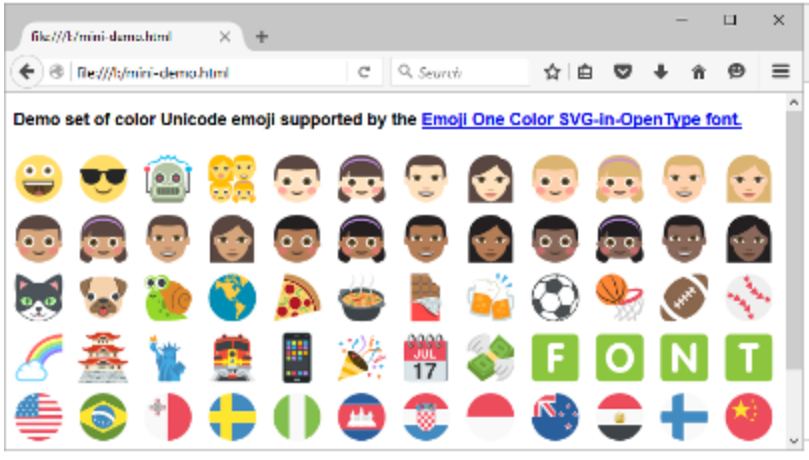


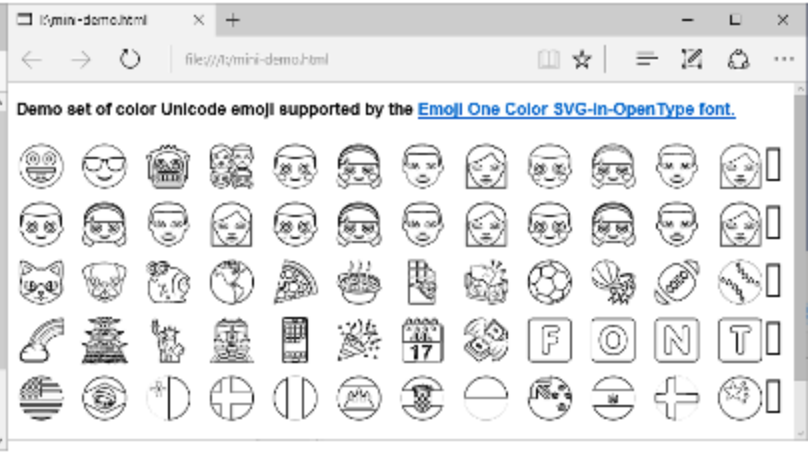
OS X 10.10





Windows 10





Developing for Unicode

If you ever need to develop Unicode parsing and processing, use the CLDR database:

http://cldr.unicode.org/

```
* Locale-specific patterns for formatting and parsing: dates, t
* Translations of names: languages, scripts, countries and regi
* Language & script information: characters used; plural cases;
* Country information: language usage, currency information, ca
* Other: ISO & BCP 47 code support (cross mappings, etc.), keyb
```

Security

Read *Unicode Security Considerations*
@ http://www.unicode.org/reports/tr36/

Restrict passwords and user names to ASCII

- For logistical reasons (customer support)
- Unicode normalisation of passwords can cause problems
- Equivalent characters

  `e` + `´` ≠ `é`
- Basic authentication can fail in different browsers

Sanitise text input

- Difficult problem
- “Unicode injection”: RTL, combining characters, wide characters
- `﷽` is one (1!) character

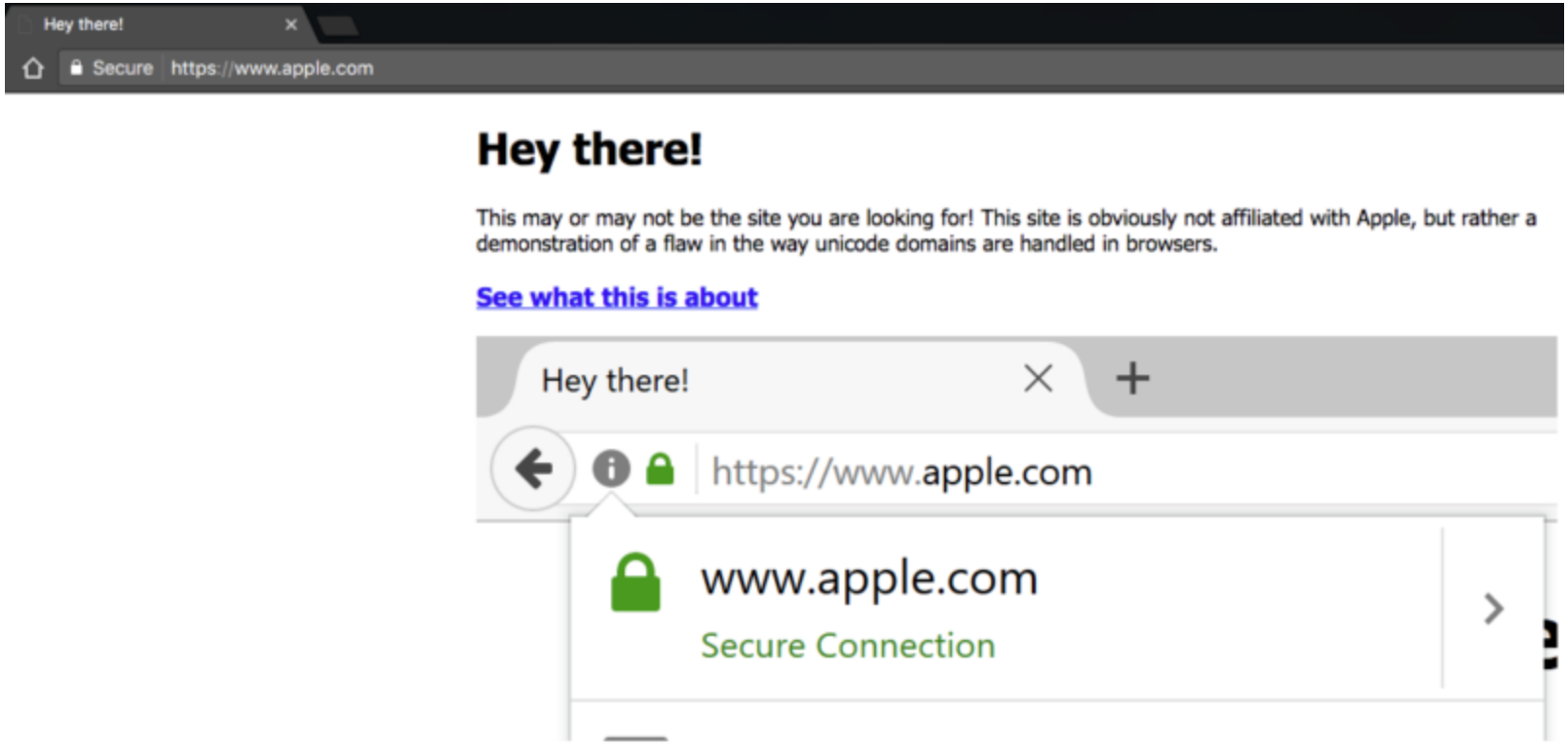
  `U+FDFD ARABIC LIGATURE BISMILLAH AR-RAHMAN AR-RAHEEM`
- Z̈A̰L͒G̰O!
- 25 different whitespace characters

https://github.com/minimaxir/big-list-of-naughty-strings

Unicode in URLs

Visit `https://www.xn--80ak6aa92e.com/` in your browser

Unicode in URLs



Unicode in URLs

`https://www.appIe.com/`

a	U+0430 CYRILLIC SMALL LETTER A
p	U+0440 CYRILLIC SMALL LETTER ER
I	U+04CF CYRILLIC SMALL LETTER PALOCHKA
e	U+0435 CYRILLIC SMALL LETTER IE

https://www.xudongz.com/blog/2017/idn-phishing/

Unicode in URLs

- Handing legit Unicode in URLs

```
http://Bücher.de
→ http://xn--bcher-kva.de
→ http://bücher.de
```

- Punycode, ASCII representation for Unicode domain names (IDN)

http://www.unicode.org/reports/tr46/

Free pizza!

```
Title: Free Pizza Fridays!
From: HR
To: You

Happy Friday!

Visit https://tech.gov.sg/free.pizza to claim a FREE 🍕!

FYNAP
- HR
```

This message could be a scam. [Report] [Ignore]

Unicode in URLs

`/ U+2044 FRACTION SLASH`

```
Visit https://tech.gov.sg/free.pizza to claim a FREE 🍕!
                          👆
```

🍕 `sg/free.pizza` 🍕

Unicode in URLs

Solution: Use Punycode where/when it makes sense to

```
Visit https://tech.gov.xn--sgfree-qq0c.pizza to claim a
FREE 🍕!
```

Click here for one neat trick to ruin bad software!

- MySQL UTF-8

  What happens when the *valid* UTF-8 string

  ```
  👽 U+1F47D EXTRATERRESTRIAL ALIEN
  ```

  is inserted into a column of

  ```
  VARCHAR CHARACTER SET utf8
  ```

Ill-formed sequences and encoding mismatches

- MySQL $<$ 5.5.3 (2010) UTF-8

```
Incorrect string value: '\xF0\x9F\x91\xBD…' for
column 'data' at row 1
```

  In MySQL, use `utfmb4` ($\geq$ 5.5.3, 2010)

https://mathiasbynens.be/notes/mysql-utf8mb4

Ill-formed sequences and encoding mismatches

-  Python 2

```
>>> '\x81'.decode('utf-8')
# UnicodeDecodeError: 'utf8' codec can't decode byte
# 0x81 in position 0: unexpected code byte
```

-  Ruby 1.9

```
'ü'.encode('ISO-8859-1') + 'ü'
# incompatible character encodings: ISO-8859-1 and
# UTF-8 (Encoding::CompatibilityError)

# or sometimes: invalid multibyte char (US-ASCII)
```

Solution: use languages/libraries which handle Unicode right

Buffer overflows

- Do not assume Unicode strings are of fixed-length

```
Fluß → FLUSS → fluss
```

```
>> 'ﷺ'.length
1

>> 'ﷺ'.normalize('NFKC').length
18
```

Solution: use languages/libraries which handle Unicode right

OS/locale filenames

- Beware simple filename sanitisation, especially on Windows
- Normalization of paths
  `c: \w i n d o w s` becomes `c:\windows`
- Character mappings
  `¥` is mapped to `\` on a Japanese-language Windows system

https://msdn.microsoft.com/en-us/library/dd374047(v=vs.85).aspx

```
> 1 + 1;
← 2

> 1 + 1;
      
← 🚑 SyntaxError: illegal character 🚑
```

```
; U+037E GREEK QUESTION MARK
```

A list of similar characters

Resources

- The Unicode Standard, v10.0 – Core Specification
- Unicode publications
- Unicode technical reports
- Unicode data files
- Unicode public files
- Emoji charts
- Emoji slides
- Unicode character inspector
- UTF-8 decoder
- Big List of Naughty Strings
- Personal names around the world
- Falsehoods Programmers Believe About Phone Numbers
- *Unicode Demystified: A Practical Programmer's Guide to the Encoding Standard* by Richard Gillam