Unicode and Ü

… things a web developer **might** want to know

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What is Unicode?

ധ	क	ʄ
U+0D27	U+0915	U+0284

Defines a unique code for every character in every language

Irrelevant of platform, program, or implementation

Punctuation marks, diacritics, symbols, arrows, and emoji are also defined

Scripts include the European alphabetic scripts, Middle Eastern right-to-left scripts, and many scripts of Asia

SUCH AS THE ENGLISH LANGUAGE!

Unicode represents a character in an abstract way

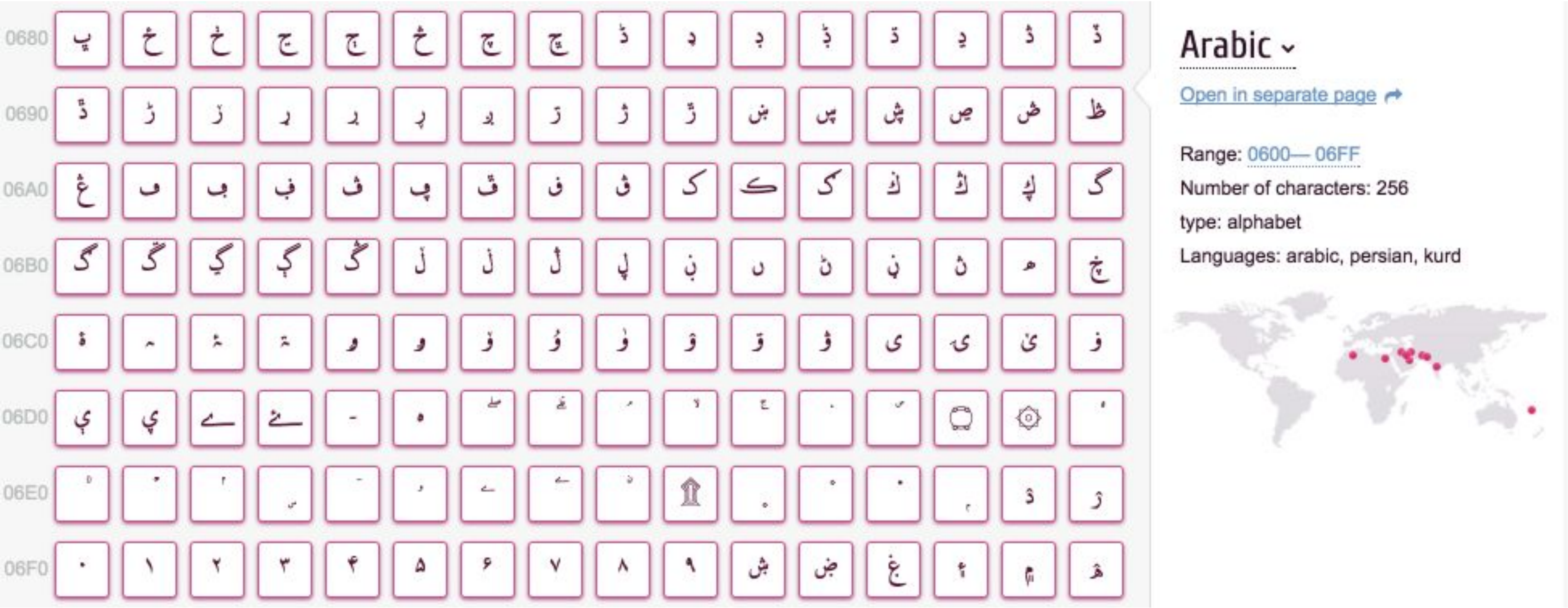
and leaves the visual rendering (size, shape, font, or style) to other software, such as a web browser

128,172

In all, the Unicode Standard, Version 9.0 provides codes for 128,172 characters from the world's alphabets, ideograph sets, and symbol collections.

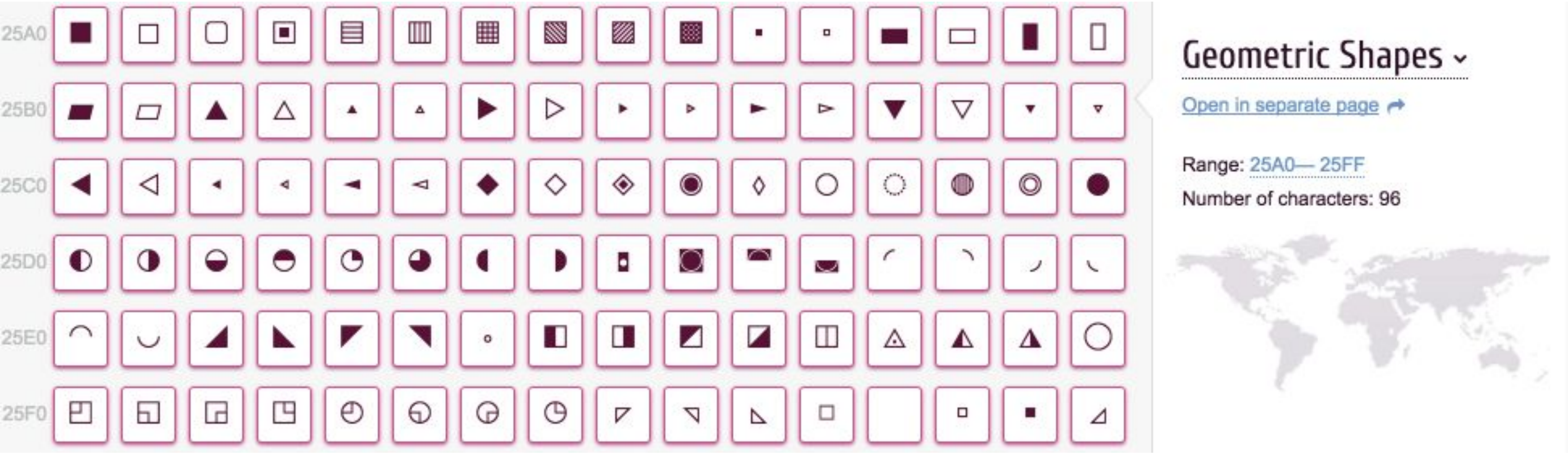
More characters are usually added each release.

Example code block



Source: unicode-table.com

Example code block



Source: unicode-table.com

Example character

Source: unicode-table.com

ASCII & FRIENDS

A bR1ef h1st0ry in time before unicode ruled

Before the web ruined everything

Life was simple - we usually didn’t care about other languages

We had ASCII and if we needed some fancy characters we’d use ISO-8859-1 or ANSI. Other characters? Other codepages!

Each character could fit nicely into 1 byte

No complex encoding, or mapping, a string is just a series of bytes which contain characters

Japanese would be Japan’s problem, not ours...

ASCII

7 bits = 128 glorious characters used most frequently in US-English

We didn’t need no british pound symbol

Character operations are simple. Uppercase? Just switch the 6th bit (genius)

1 byte mapping makes memory access simple

Emoji? We call them emoticons and you can combine them in ways unimaginable

ASCII

Character	Decimal	Binary	Hex
A	65	01000001	0x41
a	97	01100001	0x61
9	57	00111001	0x39

ASCII

000		(nul)	016	►	(dle)	032	sp	048	0	064	@	080	P	096	`	112	p
001	☺	(soh)	017	◄	(dc1)	033	!	049	1	065	A	081	Q	097	a	113	q
002	☻	(stx)	018	↕	(dc2)	034	"	050	2	066	B	082	R	098	b	114	r
003	♥	(etx)	019	‼	(dc3)	035	#	051	3	067	C	083	S	099	c	115	s
004	♦	(eot)	020	¶	(dc4)	036	$	052	4	068	D	084	T	100	d	116	t
005	♣	(enq)	021	§	(nak)	037	%	053	5	069	E	085	U	101	e	117	u
006	♠	(ack)	022	▬	(syn)	038	&	054	6	070	F	086	V	102	f	118	v
007	•	(bel)	023	↨	(etb)	039	'	055	7	071	G	087	W	103	g	119	w
008	◘	(bs)	024	↑	(can)	040	(	056	8	072	H	088	X	104	h	120	x
009		(tab)	025	↓	(em)	041	)	057	9	073	I	089	Y	105	i	121	y
010		(lf)	026		(eof)	042	*	058	:	074	J	090	Z	106	j	122	z
011	♂	(vt)	027	←	(esc)	043	+	059	;	075	K	091	[	107	k	123	{
012	♀	(np)	028	∟	(fs)	044	,	060	<	076	L	092	\	108	l	124	|
013		(cr)	029	↔	(gs)	045	-	061	=	077	M	093	]	109	m	125	}
014	♫	(so)	030	▲	(rs)	046	.	062	>	078	N	094	^	110	n	126	~
015	☼	(si)	031	▼	(us)	047	/	063	?	079	O	095	_	111	o	127	⌂

ISO-8859-1 (aka Latin1, CP819, IBM819 ...)

Add 1 bit to ASCII and you get an 8-bit, single-byte encoding that provides space for 128 additional characters

The british pound symbol is finally in! Plus 95 other symbols

Operations are still simple - working with a 1 byte to 1 character mapping

It’s not quite the same as Windows code page 1252 - more on that later

As of August 2016, 6.0% of all web sites claim to use ISO 8859-1

Additional characters from ISO-8859-1

NBSP 00A0 160	¡ 00A1 161	¢ 00A2 162	£ 00A3 163	¤ 00A4 164	¥ 00A5 165	¦ 00A6 166	§ 00A7 167	¨ 00A8 168	© 00A9 169	ª 00AA 170	« 00AB 171	¬ 00AC 172	SHY 00AD 173	® 00AE 174	¯ 00AF 175
° 00B0 176	± 00B1 177	² 00B2 178	³ 00B3 179	´ 00B4 180	µ 00B5 181	¶ 00B6 182	· 00B7 183	¸ 00B8 184	¹ 00B9 185	º 00BA 186	» 00BB 187	¼ 00BC 188	½ 00BD 189	¾ 00BE 190	¿ 00BF 191
À 00C0 192	Á 00C1 193	Â 00C2 194	Ã 00C3 195	Ä 00C4 196	Å 00C5 197	Æ 00C6 198	Ç 00C7 199	È 00C8 200	É 00C9 201	Ê 00CA 202	Ë 00CB 203	Ì 00CC 204	Í 00CD 205	Î 00CE 206	Ï 00CF 207
Ð 00D0 208	Ñ 00D1 209	Ò 00D2 210	Ó 00D3 211	Ô 00D4 212	Õ 00D5 213	Ö 00D6 214	× 00D7 215	Ø 00D8 216	Ù 00D9 217	Ú 00DA 218	Û 00DB 219	Ü 00DC 220	Ý 00DD 221	Þ 00DE 222	ß 00DF 223
à 00E0 224	á 00E1 225	â 00E2 226	ã 00E3 227	ä 00E4 228	å 00E5 229	æ 00E6 230	ç 00E7 231	è 00E8 232	é 00E9 233	ê 00EA 234	ë 00EB 235	ì 00EC 236	í 00ED 237	î 00EE 238	ï 00EF 239
ð 00F0 240	ñ 00F1 241	ò 00F2 242	ó 00F3 243	ô 00F4 244	õ 00F5 245	ö 00F6 246	÷ 00F7 247	ø 00F8 248	ù 00F9 249	ú 00FA 250	û 00FB 251	ü 00FC 252	ý 00FD 253	þ 00FE 254	ÿ 00FF 255

ISO-8859-?

Actually there are a bunch of ISO-8859 definitions, not just ISO-8859-1

They all swap out the same range of characters (decimal 160-255)

Latin-1 (Western European languages)
Latin-2 (Non-Cyrillic Central and Eastern European languages)
Latin-3 (Southern European languages and Esperanto)
Latin-5 (Turkish)
Latin-6 (Northern European and Baltic languages)
8859-5 (Cyrillic)
8859-6 (Arabic)
8859-7 (Greek)
8859-8 (Hebrew) ...

Windows Codepage 1252

Uses the unused range of ISO-8859-1 (DECIMAL 128-159) to provide additional characters

Sometimes referred to as “ANSI”

Gives you that *nice* dash that’s just a little bit longer than a plain old hyphen

1252 is basically the reason we needed to add “Paste from Word” to our web applications

–	-
DEC: 150	DEC: 45

Windows Codepage 1252

p 0070 112	q 0071 113	r 0072 114	s 0073 115	t 0074 116	u 0075 117	v 0076 118	w 0077 119	x 0078 120	y 0079 121	z 007A 122	{ 007B 123	| 007C 124	} 007D 125	~ 007E 126	DEL 007F 127
€ 20AC 128		‚ 201A 130	ƒ 0192 131	„ 201E 132	… 2026 133	† 2020 134	‡ 2021 135	ˆ 02C6 136	‰ 2030 137	Š 0160 138	‹ 2039 139	Œ 0152 140		Ž 017D 142	
	‘ 2018 145	’ 2019 146	“ 201C 147	” 201D 148	• 2022 149	– 2013 150	— 2014 151	˜ 02DC 152	™ 2122 153	š 0161 154	› 203A 155	œ 0153 156		ž 017E 158	Ÿ 0178 159
NBSP 00A0 160	¡ 00A1 161	¢ 00A2 162	£ 00A3 163	¤ 00A4 164	¥ 00A5 165	¦ 00A6 166	§ 00A7 167	¨ 00A8 168	© 00A9 169	ª 00AA 170	« 00AB 171	¬ 00AC 172	SHY 00AD 173	® 00AE 174	¯ 00AF 175

Before Unicode

Before unicode there were 100’s of different encoding systems - issues

No single encoding could contain enough characters (eg. European Union spans many encodings)

The encoding systems would also conflict with each other. Eg. Two different characters at the same address -OR- the same character defined in two different places

Unsuitable for East-Asian languages requiring 1000’s codepoints

Does not cater for additional symbols

Back to Unicode

Unicode

So Unicode gives us a 21bit space U+0000..U+10FFFF to provide allocation for over a million codepoints

Unicode only specifies the codepoint or the “number” to reference that character, how that codepoint is represented on disk or in memory is a whole other story

The Unicode Space

Unicode allows for ~1.1million codepoints to be allocated across 17 “planes”

Each plane - 65,536 continuous characters (16 bits)

Basic Multilingual Plane (BMP) is the first plane and contains the character assignments for most of the modern languages and common symbols

There are 3 supplementary planes, plus private use blocks across multiple planes

The other planes are sometimes referred to as: *Astral Planes*

The Unicode Space

Plane 0	**Basic Multilingual Plane** (BMP)	U+0000 - U+FFFF
Plane 1	Supplementary Multilingual Plane (SMP)	U+10000 - U+1FFFF
Plane 2	Supplementary Ideographic Plane	U+20000 - U+2FFFF
Planes 3-13	Unassigned	U+30000 - U+DFFFF
Plane 14	Supplement-ary Special-purpose Plane (SSP)	U+E0000 – U+EFFFF
Planes 15-16	Supplement-ary Private Use Area planes (SPUA)	U+F0000 + U+10FFFF

BMP - Basic Multilingual Plane

The first plane **plane 0** is called the Basic Multilingual Plane or BMP

It specifies the codepoint range `U+0000` -> `U+FFFF`

It contains all the most commonly used symbols, english scripts, and many modern languages

Most of the time you don’t need any code points outside of the BMP especially for text documents in English. Just like any other Unicode plane, it groups about 65 thousand symbols

Encoding Formats

Unicode Transformation Format (UTF)

UTF specifies the encoding for a codepoint (eg. codepoint -> memory/storage)

UTF-8, UTF-16, and UTF-32 all provide different ways to encode a codepoint into between 1 and 4 bytes

Only these encodings are part of the Unicode Standard - but there are many more

All interchangeable - no loss when converting between each

UTF-8

Variable width encoding from 1-4 bytes

Designed to be compatible with ASCII - the first 128 characters correspond 1:1 with ASCII

Therefore ASCII is also completely valid UTF-8

UTF-8 does not require BOM although it is sometimes present

Most common on the web, HTML5 mandates its use

Bytes	Bits For code point	First code point	Last code point	Byte 1	Byte 2	Byte 3	Byte 4
1	7	U+0000	U+007F	**0**xxxxxxx			
2	11	U+0080	U+07FF	**110**xxxxx	**10**xxxxxx		
3	16	U+0800	U+FFFF	**1110**xxxx	**10**xxxxxx	**10**xxxxxx	
4	21	U+10000	U+10FFFF	**11110**xxx	**10**xxxxxx	**10**xxxxxx	**10**xxxxxx

1-4 bytes - first byte for characters in the ASCII range

UTF-8 Binary Encoding

Working with UTF-8 at the Byte Level

You have a single byte character if the first bit is a **0 (zero)**

You know you have the first byte in a sequence if the first two bits are **11**

If you have a byte that starts with **10**, you will need to seek up to 3 bytes backwards to find the start of the sequence

With this knowledge we can randomly seek and read 1 byte anywhere in a UTF-8 encoded file and know how to proceed

UTF-8 encoding of ASCII characters

Character	Decimal	Binary	Hex
A U+0041	65	01000001	0x41
A U+0061	97	01100001	0x61
9 U+0039	57	00111001	0x39
Æ U+006C	50054	11000011 10000110	0xC3 0x86

UTF-16

Variable width encoding that uses either 16 bits or 32 bits for all codepoints

All of the characters in the Basic Multilingual Plane (BMP) are encoded as a single 16-bit unit - thus most characters of most modern languages only use one code unit

Other planes require two 16-bit units (32 bits) and we call this “surrogate pairs”

Used by Windows and Java for string/char storage

UTF-16

Characters U+0800 through U+FFFF use three bytes in UTF-8, but only two in UTF-16

As a result, text in (for example) Chinese, Japanese or Hindi will take more space in UTF-8 if there are more of these characters than there are ASCII characters

Comes in 2 forms UTF-16LE and UTF-16BE   (Little Endian or Big Endian)

Not compatible with ASCII

UTF-32

32 bit (4 byte) encoding… 4 bytes for every character no matter which character

Fixed width makes codepoints directly indexable (Constant time operation)

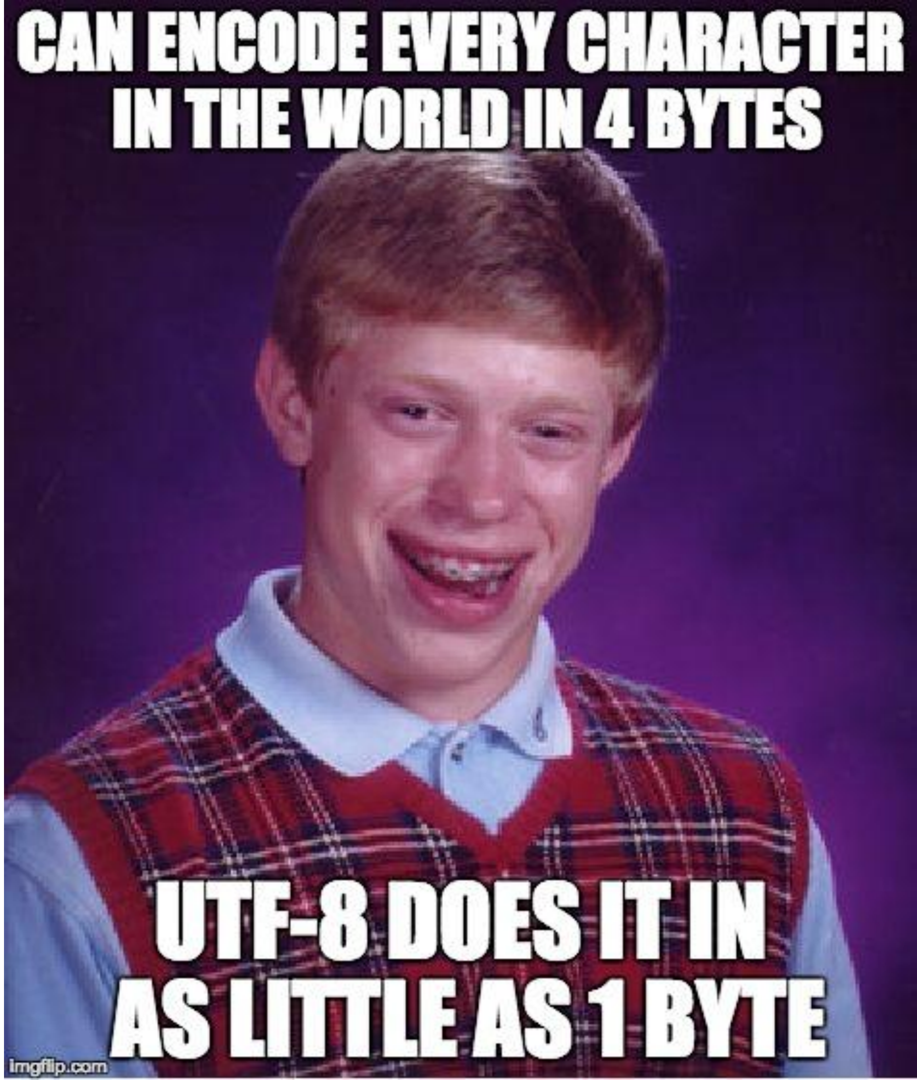
Used by Linux and OSX for w_char (wide char) storage

Uses more memory than the other standards, but easier to address

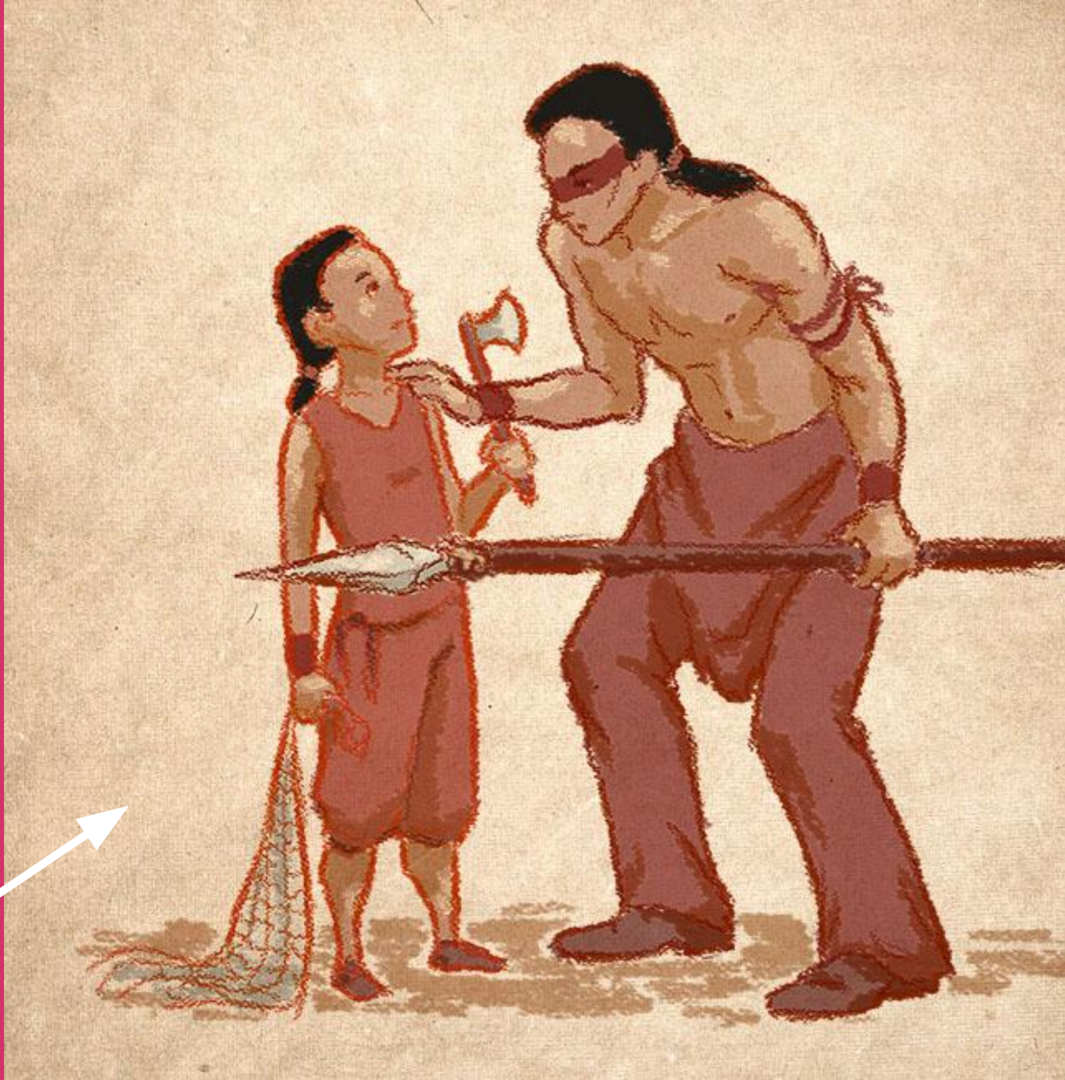
Comes in 2 forms UTF-32LE and UTF-32BE (Little Endian or Big Endian)

Not compatible with ASCII

Bad luck
UTF-32



Little Endian
Big Endian



NO,
THEY'RE NATIVE AMERICAN'S

Little Endian & Big Endian Variations

UTF-16 and UTF-32 may be in LE (Little Endian) or BE (Big Endian) encoding

Big Endian means most significant byte first (normal)

Little Endian means least significant byte first (reverse)

Some computers are better at one or the other

Byte order mark (BOM) “can” be used to indicate LE or BE
… or specify the encoding through some other means

You must know which order it is encoded in!

Recap

UTF-8 is most common on the web, and *potentially* uses the least storage (1 byte)

UTF-16 is either 2 or 4 bytes, used by Java and Windows, and uses less storage than UTF-8 when dealing with certain scripts. All characters in the BMP are 1 unit

UTF-8 and UTF-32 are used by Linux and various Unix systems

UTF-32 always uses 4 bytes but can be addressed more easily due to fixed width

The conversions between all of them are algorithmically based, fast and lossless

ASCII	UTF-8 (Most popular on the web)	UTF-16	UTF-32
1 byte	1-4 bytes	2-4 bytes	*Always* 4 bytes
Simple to use	Flexible encoding length	Better outside the BMP	Good for internal storage
Plain old text	✓ Single Encoding	✓ Supports LE & BE	✓ Supports LE & BE
✓ Constant Access	Variable Access	Variable Access	✓ Constant Access
✓ HTML Support	✓ HTML Support	✓ HTML Support	HTML Support
	✓ Recommended by W3C		
✓ Customise your extra bits			
Emoji	✓ Emoji	✓ Emoji	✓ Emoji
128 characters upgrade to iso-8859-1 available	1.1 million characters	1.1 million characters	1.1 million characters

Byte Order Mark (BOM)

Byte Order Mark (BOM) U+FEFF

An **optional** Unicode character which appears at the start of **some** text streams

Indicates that it a stream is in Unicode

Indicates the encoding (eg. UTF-8, UTF-16, UTF-32)

Indicates endianness (byte order)

If you specify your encoding through some other means then a BOM
is not necessary

Sometimes causes issues

Byte Order Mark (BOM) U+FEFF

The exact bytes comprising the BOM will be whatever the Unicode character U+FEFF is converted into by that transformation format

The BOM can be used to “sniff” the format of the file or stream

If present in UTF-8 the BOM will always be the 3 bytes: EF BB BF

UTF-8 does not require a BOM and UTF-8 should always ignore the BOM

Bytes	Encoding Form
00 00 FE FF	UTF-32, big-endian
FF FE 00 00	UTF-32, little-endian
FE FF	UTF-16, big-endian
FF FE	UTF-16, little-endian
EF BB BF	UTF-8

Unicode Equivalence

And normalization and stuff ...

Unicode Equivalence

Unicode sometimes has multiple representations for the same character

Ultimately they all represent the “same” character, but with different codepoints - we call them equivalent

Sometimes these additional codepoints exist for historical reasons

Unicode provides rules around normalisation so that they can be transformed and/or treated as the same character (eg. when comparing or alphabetising)

For Example

U+00C5 (Å) LATIN CAPITAL LETTER A WITH RING ABOVE

U+212B (Å) ANGSTROM SIGN

U+0041 (A) LATIN CAPITAL LETTER A + U+030A (̊) COMBINING RING ABOVE

All of the above are considered ***canonically equivalent***

Each of these examples represent the same character

1. The first is the “precomposed” form
2. The second is an alternative codepoint called “Angstrom”
3. The last combines a character with a diactritic

Normalisation

There are 4 forms of normalisation:

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

Fonts

Fonts

The Unicode standard does not specify or create the font (typeface)

A font is a collection of graphical shapes (glyphs) that may include representations of some of the unicode codepoints.

Since a single TTF or OTF font has a hard limit of 65535 there is no single font that can cover the 1.1 million unicode characters - a family of fonts needs to be used

Fonts - Unicode in the browser

If the fonts referenced in the CSS do not cover a particular Unicode character then the browser will use fallback fonts

> *By the specifications, browsers should display a character if there is any font in the system that contains it*

Font fallback doesn't always occur nicely (looking at you IE)

Using a font that has good coverage for your application is the ideal scenario

Or use SVG or images for particular instances

Fonts - Coverage

Google Noto Font - https://www.google.com/get/noto/
Provides massive coverage (goal is to cover all scripts) including emoji (android style) and many scripts

DejaVu - http://dejavu-fonts.org/wiki/Main_Page
Good coverage of most common Unicode symbols and common scripts

GNU - Unifont - http://czyborra.com/unifont/ (Pixel font)
30,000+ characters in pixel format

Fonts - Coverage

Wikipedia provide coverage tables for the various commonly installed fonts (Arial etc.) which indicates which block ranges are included:

https://en.wikipedia.org/wiki/Unicode_font#0000-077F

Emoji

💩 🐍 😂

U+1F4A9 U+1F40D U+1F602

Emoji History

Originated in Japanese mobile phones in 1990’s

In 2010 the Unicode consortium integrated emoji into Unicode

There are over 1700 emoji including flags, keycaps, and modifier sequences

The word “emoji”, in fact, is just as Japanese as it sounds. It’s taken from the Japanese words “e” (“picture”), and “moji” (“character”).

Emoji Definition

They are assigned code points just like other Unicode characters

Depicted as black and white pictographs within the Unicode standard

As with all Unicode characters, graphical representation is up to the software

Emoji are not the same as emoticons… but some emoticons include unicode characters ಠ_ಠ

Emoji Examples

Actual implementations differ within various software

№	Code	Brow.	Chart	Apple	Goog[d]	Twtr.	One	FBM	Wind.	Sams.
1	U+1F923			—				—		
№	Code	Brow.	Chart	Apple	Goog[d]	Twtr.	One	FBM	Wind.	Sams.
2	U+1F924			—				—		
№	Code	Brow.	Chart	Apple	Goog[d]	Twtr.	One	FBM	Wind.	Sams.
3	U+1F920			—				—		
4	U+1F921			—				—		
5	U+1F925			—				—		
№	Code	Brow.	Chart	Apple	Goog[d]	Twtr.	One	FBM	Wind.	Sams.
6	U+1F922			—				—		
7	U+1F927			—				—		

Emoji Skin Tones

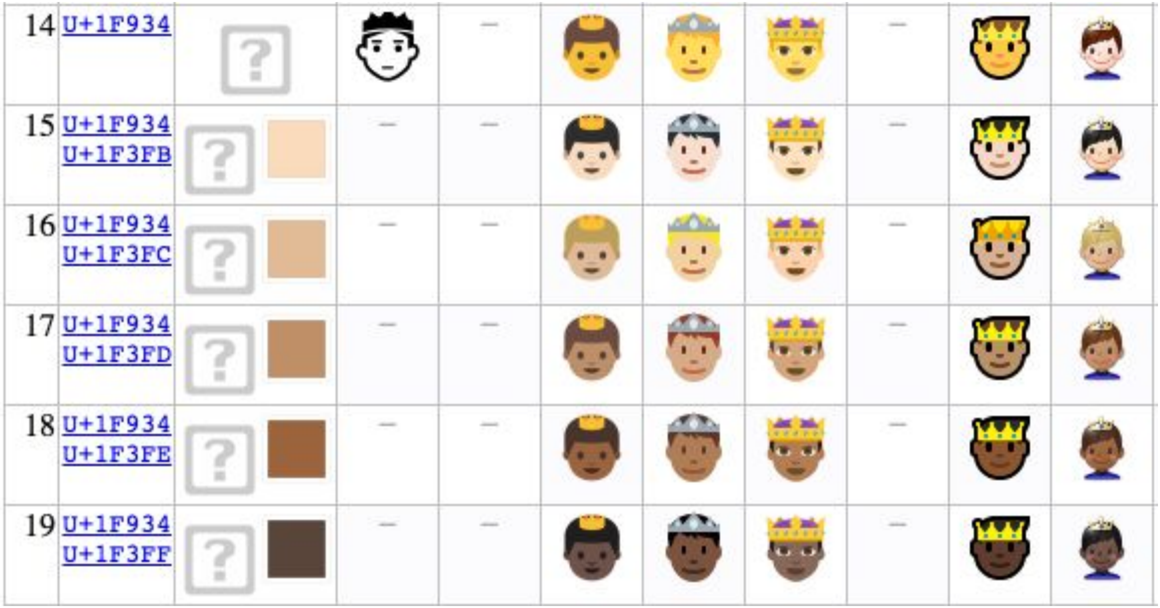
In 2015 (Unicode 8.0) skin tones based on the Fitzpatrick scale were introduced

Many emoji such as people could be assigned up to 5 different shades by combining a modifier character

When an emoji codepoint is present, if it is immediately followed by one of the following codepoints: U+1F3FB, U+1F3FC, U+1F3FD, U+1F3FE, U+1F3FF - then if the software supports it it should display the skin tone variation

Otherwise the patch colour block will be displayed individually after the emoji character

Emoji Prince - U+1F934



14	U+1F934	?		—				—		
15	U+1F934 U+1F3FB	?	—	—				—		
16	U+1F934 U+1F3FC	?	—	—				—		
17	U+1F934 U+1F3FD	?	—	—				—		
18	U+1F934 U+1F3FE	?	—	—				—		
19	U+1F934 U+1F3FF	?	—	—				—		

The skin tone modifiers for the Prince (U+1F934) emoji character

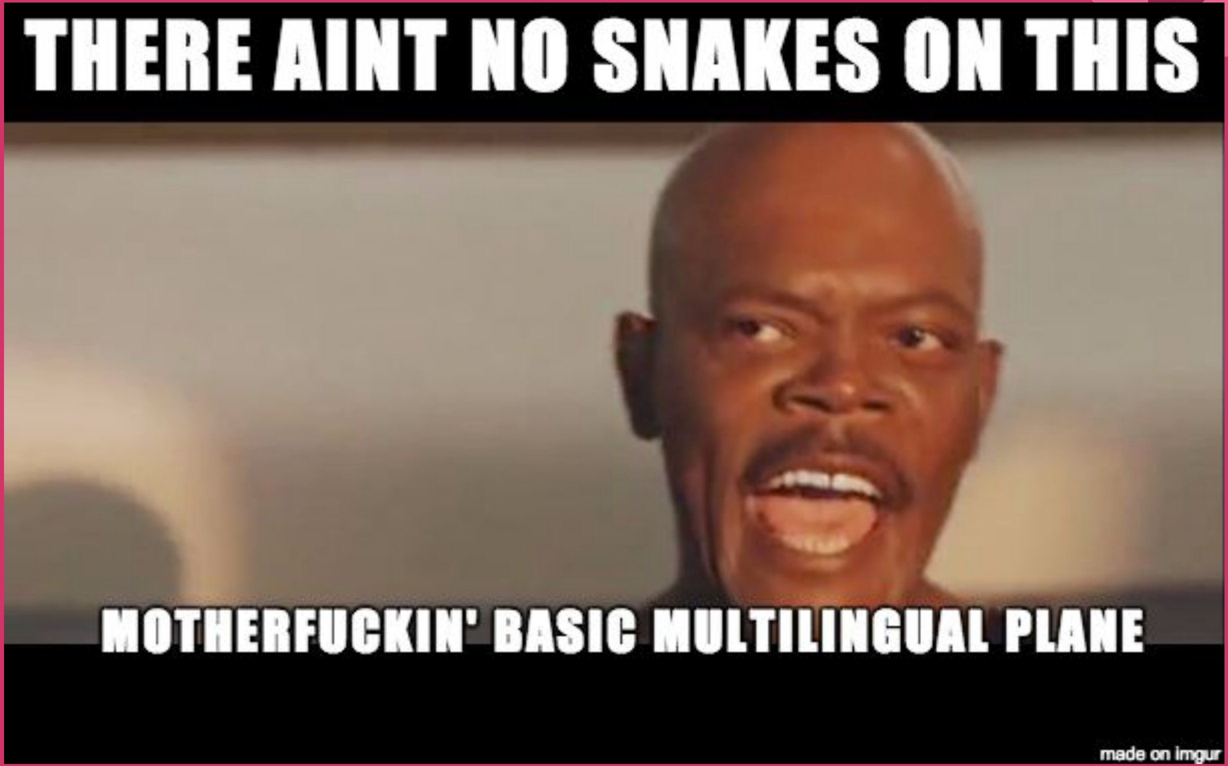
Emoji

As seen from the example characters their codepoint is beyond `U+FFFF`

Emoji reside in the Supplementary Multilingual Plane (SMP) `U+10000 - U+1FFFF`

Since they are not available within the BMP (Basic Multilingual Plane) they will take at least 2 bytes to encode in any of the UTF forms

Plane 1, the Supplementary Multilingual Plane (SMP), contains historic scripts such as Linear B, Egyptian hieroglyphs, and cuneiform scripts; historic and modern musical notation; mathematical alphanumerics; Emoji and other pictographic sets



Supplementary plane

PHP Unicode

PHP Unicode

Does not support unicode at a low-level, work-arounds are required

Internally PHP stores as byte strings. PHP6 *was* going to change all that

Provides functions for working with Unicode/UTF-8 strings

String assignment and concatenation will still work without special consideration

`strpos()` and `strlen()` etc. will count bytes, not characters, so use multibyte aware functions instead…

Programmer must be aware to avoid *Mojibake*

PHP Unicode - Set Your Charset

Set `default_charset` in php.ini to “UTF-8”

Specify UTF-8 in your Content-Type header:

```
header(“Content-Type: text/html; charset=utf-8”);
```

Set the charset on your PDO connection DSN:

```
new PDO('mysql:host=your-hostname;dbname=your-db;charset=utf8mb4', …);
```

PHP Unicode - Set Your Encoding

Explicitly pass "UTF-8" as the encoding parameter to `htmlspecialchars`() and `htmlentities`()

Use `mb_internal_encoding`() and `mb_http_output`() at the start of all PHP files to ensure that PHP considers your strings as UTF-8 and it outputs UTF-8 to the browser

Save your source files encoded as UTF-8 - without a Byte Order Mark (BOM)

PHP Unicode - Use Multibyte Functions

PHP provides mbstring (mb_*) functions for multi-byte string handling - these should be used in ALL cases when working with unicode

`mb_strlen(), mb_substr(), mb_strpos(), mb_send_mail()` etc.

These functions will correctly work on the character level rather than byte level

The `iconv` functions can be used for converting to/from Unicode encodings such as UTF-8, as well as detecting encodings of input

PHP Unicode - JSON

json_encode() may break your UTF-8...

Well, by default json_encode() escapes UTF-8 as unicode escape sequences by default:

`json_encode('č') => "\u010d"`

As of PHP5.4 you can pass an additional flag called `JSON_UNESCAPED_UNICODE`:

`json_encode('č', JSON_UNESCAPED_UNICODE) => "č"`

Note that `json_decode` will handle either.

PHP Unicode - PHP7

PHP 7 now allows you to specify Unicode codepoints using the \u{XX..} syntax which will be output as UTF-8:

```
echo "\u{aa}";  // Can also be specified with leading 0’s eg. \u{0000aa}
=> ª
```

```
echo "\u{9999}";
=> 香
```

PHP7 also includes the Intl extension which includes a lot of great functionality for working with Unicode normalization and plenty of other International good-ness.

Database

Databases and Unicode

Every modern database supports Unicode

Implementation differs slightly but most have the concept of CHARSET and COLLATION

The CHARSET defines how the data is encoded

The COLLATION defines the semantics - sorting and comparison

MySQL

MySQL still defaults to `latin1` charset when not specified and latin1_swedish_ci for the collation - as of 5.7

In MySQL the `utf8` charset refers to a 3 byte implementation of of UTF-8, which is usually not what you want when working with UTF-8

Use `utfmb4` - *not* the `utf8` collation or your may have data loss

Each character set has a default collation

MySQL - Unicode charsets

`utf8` - UTF-8 encoding using 1-3 bytes per character

`utf8mb4` - UTF-8 encoding using 1-4 bytes per char

`ucs2` - UCS-2 encoding using 16 bits per character

`utf16` - UTF-16 encoding 16 bits per character (like ucs2) but with support for supplementary characters

`utf32` - UTF-32 encoding using 32 bits per character

MySQL Collation

For every CHARSET there will be several collations available: xxx_general_ci, xxx_bin, xxx_unicode_ci, plus language specific collations; xxx_swedish_ci etc.

The collation used determines how strings are sorted, how strings are compared, and how indexes are built

The language specific collations such as xxx_swedish_ci

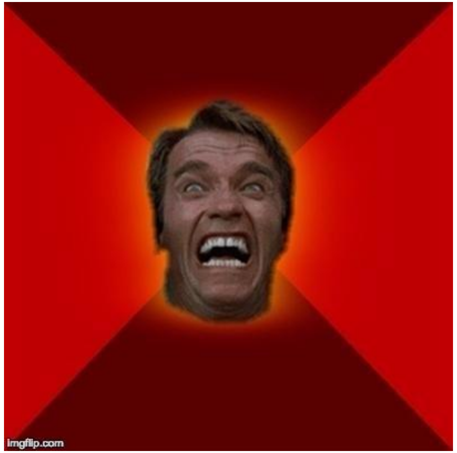
For Example

utf8_unicode_ci supports mappings such as expansions;

That is... when one character compares as equal to combinations of other characters.

For example, in German and some other languages

ß is equal to ss



MySQL - Which collation?

Operations performed using the **xxx_general_ci collation are faster** than those for the xxx_unicode_ci collation **but slightly less correct**

xxx_bin is even faster, it works solely on code points - without normalization etc. during comparison

xxx_unicode_ci also supports contractions and ignorable characters

xxx_general_ci is a legacy collation that does not support expansions, contractions, or ignorable characters:
only one-to-one comparisons between characters.

MySQL - Declaring Charset

Connect to the database using the same encoding (so that there is no mangling between database and client)

`SET NAMES utf8mb4 COLLATE utf8mb4_unicode_ci` before you query/insert into the database

Ensure all your tables and columns are also in the same encoding.
Use `DEFAULT CHARSET=utf8mb4`

MySQL - Configuration

Update your MySQL configuration file (my.cnf)

```
[client]
default-character-set = utf8mb4

[mysql]
default-character-set = utf8mb4

[mysqld]
character-set-client-handshake = FALSE
character-set-server = utf8mb4
collation-server = utf8mb4_unicode_ci
```

You can confirm these changes by issuing the following query:

```
SHOW VARIABLES LIKE 'character_set%';
```

MySQL - Configuration

Note that the **client-set-handshake=FALSE**

This means that the client handshake will be ignored, and the server will *insist* on the character set that is used during communication.

MySQL - Column storage

`varchar(10)` column within a utf8mb4 table will use between 1 and 40 bytes for a non-empty value

`char(10)` column will always use 40 bytes (pessimistic)

`varbinary` might show a slight improvement for columns which don't need locale side effects - eg. identifiers that don't need UTF-8 - eg. static values (such as a status column) are good candidates

MySQL's named column types (tinytext) etc. refer to byte size

Key length might be a concern

MySQL - String functions

The `LENGTH()` function returns length in **bytes** - use `CHAR_LENGTH()` to get the number of characters

```
SELECT CHAR_LENGTH('Ж'), LENGTH('Ж');
CHAR_LENGTH = 1, LENGTH = 2
```

The other string functions behave as you would expect - they work on the character level: SUBSTR, CONCAT etc.

PostgreSQL - Installation

For new installs - initialise your database cluster as UTF8:
initdb -E UTF8   … On Debian or Ubuntu that’s: pg_createcluster

The locale you use should match your system UTF-8 locale:

```
# cat /etc/default/locale

#  File generated by update-locale
LANG="en_US"
LANGUAGE="en_US:"
LC_ALL=en_US.UTF-8
```

PostgreSQL - Encoding

PostgreSQL defines the encoding for a table in 3 ways:

ENCODING = How the characters are encoded eg. UTF-8

LC_COLLATE = String sort order

LC_CTYPE = Character classification (What is a letter? Its upper-case equivalent?)

PostgreSQL - Database creation

```
CREATE DATABASE "mydatabase"
    WITH OWNER "somebody"
    ENCODING 'UTF8'
    LC_COLLATE = 'en_US.UTF-8'
    LC_CTYPE = 'en_US.UTF-8'
    TEMPLATE template0;
```

Notice that the above commands specify copying the template0 database. When copying any other database, the encoding and locale settings cannot be changed from those of the source database, because that might result in corrupt data.

PostgreSQL - Existing databases

Use psql -l to inspect your current database collations:

```
   Name     |   Owner    | Encoding |   Collate   |    Ctype    |   Access privileges
-----------+-----------+----------+-------------+-------------+-----------------------
 iris       | iris       | UTF8     | en_US.UTF-8 | en_US.UTF-8 |
 postgres   | postgres   | UTF8     | en_US.UTF-8 | en_US.UTF-8 |
 template0  | postgres   | UTF8     | en_US.UTF-8 | en_US.UTF-8 | =c/postgres          +
            |            |          |             |             | postgres=CTc/postgres
 template1  | postgres   | UTF8     | en_US.UTF-8 | en_US.UTF-8 | =c/postgres          +
            |            |          |             |             | postgres=CTc/postgres
```

PostgreSQL - Client

Ensure the client communicates in UTF-8

```
SET NAMES 'UTF8';   // Same as initialise via PDO
```

To query the current client encoding:

```
SHOW client_encoding;
```

To return to the default encoding:

```
RESET client_encoding;
```

PostgreSQL - String functions

Postgres provides the convert function for converting strings between encodings:

```
convert(string using conversion_name)
```

```
convert(string text, [src_encoding name,] dest_encoding name)
```

Eg.

```
convert('PostgreSQL' using iso_8859_1_to_utf_8)
convert( 'text_in_unicode', 'UNICODE', 'LATIN1')
```

There are many built in conversions. See pgsql docs

HTML

HTML - History

In the early days of HTML (HTML 2.0), the document character set was specified as ISO-8859-1

HTML 4.0 was extended to support the Universal Character Set (UCS) which Unicode is basically a superset of

According to the HTML5 standard - all HTML authoring should now use UTF-8

HTML - Declaring Your Character Set

Always declare your charset as UTF-8:

```
<meta charset="utf-8">
```

<- shorter, better

```
<meta http-equiv="Content-Type" content="text/html; charset=utf-8" />
```

In HTML5 they're both the **same**, so use the shortest one!

Charset declaration should be placed right after the <head> so that browser can parse the rest of the document correctly

CSS

CSS files may contain Unicode characters (font names, content: “xx”)

The header or the document linking to the CSS will determine the perceived encoding - so what if a UTF-16 HTML file links to your CSS encoded in UTF-8

Always `@charset "UTF-8";` as the first line of your file

HTML - Encoding

Your HTML files should also be encoded in UTF-8 when authoring

If your HTML file is encoded in UTF-16 then the browser can't read the charset declaration to know the encoding so it must rely on header or heuristics.

From high to low priority, HTML5 uses the encoding of:
1. User override for charset (browser config)
2. "Content-Type" header from server
3. Document charset declaration
4. Byte Order Mark or detection heuristics (analysis of document)

HTML - Entities

HTML entities are a plain text encoding of a character which can be passed and stored through plain text mechanisms

Entities can be used regardless of the encoding of the document

Any unicode character can be referenced by its Uncode codepoint via `—` or via the hex form `—`

HTML entities also have named versions such as `—` - all three will render the same character - there is a standard set of 252 named character entities for characters

HTML - Forms

`<form>` supports `accept-charset=”utf-8”` attribute

This is only relevant if your document encoding is not already UTF-8

Within a UTF-8 document, the browser will encode user input within a `<form>` as UTF-8

Javascript

Javascript

Javascript uses unicode as storage 👏

All strings are internally stored as UTF-16... or UCS-2 □

Source code (from ECMAscript 3.0) is specified as unicode too 👏

But many of the string functions respond differently than you would expect □

ES6 provides additional functionality for working with Unicode 😏

Javascript - Preparation

Make sure your JS files are saved in UTF-8 encoding

.. or only refer to codepoints using escape sequences `\uHHHH`

Send utf-8 header for your JS files

Also declare your `<html>` charset as utf-8

Charset attribute within `<script>` is only necessary if your document encoding is different or no headers were sent with the JS file:

```
<script src="/js/stuff.min.js" charset="utf-8"></script>
```

Javascript - Working with Unicode

XMLHttpRequest URL encoded form-data will always be sent as UTF-8 encoding as per the HTML5 spec.

The response encoding will be determined by the Content-Type header received (containing a charset declaration), or via a BOM, or via “sniffing” the content and/or via the current document encoding

Javascript - Working with Unicode

The way Javascript handles unicode can sometimes be surprising

JavaScript strings are represented using UTF-16 code units

Any character within the BMP (U+0000 to U+FFFF) can be represented using a single code unit, others require two units

```
'☘'.length;
= 1        // Looks good!

'☘' == '\u2618';
= true     // You can use unicode escapes
```

Javascript - Character storage

In Javascript characters such as emoji require two 16-bit code units. These continuous code units are often called surrogate pairs

And Javascript string and character functions actually work on code units rather than characters:

```
'💩'.length = 2  // Returns the number of 16-bit code units - not chars
```

The string above actually contains two code units:

```
'💩' == '\uD83D\uDCA9'
```

Javascript - Some problems

```
'💩'.split('').reverse().join('');  // JS4EVA
= '��'   // Reversed the code units to: '\uDCA9\uD83D'

var str = '💩☘';
for (var i = 0; i < str.length; i++) {
    console.log(str[i]);
}
= �
= �
= ☘
```

Javascript - Solutions

Javascript can handle Unicode just fine… as long as you don’t touch anything

If you don’t try to work on the character level, you may not encounter problems

Maybe don’t use characters outside of the BMP

Definitely don’t try sorting your strings...

And don’t even bother comparing two de-normalized strings...

...

… ES6!

Javascript - ES6 🚀

ES6 brings several long-needed unicode improvements to Javascript

Unicode codepoint escapes \u{1F680} - so we work with the entire codepoint rather than the individual code units \uD83D\uDE80

String.prototype.codePointAt() and String.fromCodePoint() for converting between characters 🚀 and Unicode code points \u{1F680}

String.prototype.normalize() for normalising a string (ie. for comparing/sorting)

String iterator and spread operator ...

Javascript - ES6 string iterables

The string iterator in ES6 splits strings along codepoint boundaries

```
for (let ch of 'x\uD83D\uDE80y') {
  console.log(ch.length)
}

// ch.length = 1

// ch.length = 2

// ch.length = 1
```

Javascript - ES6 spread operator

The spread operator allows us to easily split a string into an array over its codepoints:

```
let chars = [...'abc']     // ['a', 'b', 'c']
```

We can use this to correctly count the characters in a string:

```
let chars = [...'🐎□❤']  // ['🐎', '□', '❤']
chars.length     // 3
```

Javascript - ES6 spread operator

Your string may have been constructed using unicode characters, unicode codepoint sequence, or UTF-16 unicode sequences:

```
[...'🍀 ym elots \u{1F984} a \uD83D\uDCA9 ho'].reverse().join('')

        // oh 💩 a 🦄 stole my 🍀
```

Regardless, the spread operator splits individual codepoints into an array, and therefore can be used with `reverse()` etc.

Javascript - ES6 getCodePointAt

`String.prototype.getCodePointAt(pos)` returns the decimal value for a Unicode character within a string:

```
const chars = '□A'    // String containing unicorn char and letter ‘A’
chars.codePointAt(0)  // 129412  -- decimal value
'\\u{' + chars.codePointAt(0).toString(16).toUpperCase() + '}'
       // \u{1F984} -- The unicode escape sequence
```

BUT ...

```
chars.codePointAt(1)  // 56708  -- not 65!
```

Position is still based on 16-bit code units - use spread etc!

Javascript - ES6 fromCodePoint

Converting from a codepoint to character is easy in ES6 too:

```
String.fromCodePoint(65);          // "A"    "\u0041"
String.fromCodePoint(0x404);       // "Ɣ"    "\u0404"
String.fromCodePoint(0x2F804);     // "□"   "\uD83E\uDD84"
String.fromCodePoint(129412);      // "□"   "\uD83E\uDD84"
```

```
let allTheUnicorns = "□"
allTheUnicorns += String.fromCodePoint(129412)
allTheUnicorns += String.fromCodePoint(0x2F804)
// □□□ - a beautiful tricorn!
```

Closing Comments

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Just use UTF-8

UTF-8 all the things

In your headers, in your encodings, in your database, and through UTF-8 aware functions

Think about your input, how you’re handling it, how you’re storing it, how you’re displaying it, and how you manipulate it

It’s easy! Unicode is normally only a problem when one or more pieces of your stack or request cycle do not use the same encoding