Characters

COMP370
Introduction to Computer Architecture

Goals for Today

- Understand how character data is represented and displayed.

Bits are Bits

- A bunch of bits can represent many things, numbers, logical values or characters.

```
/* C++ character used in different ways. */
char  stuff;
stuff = 'A';
stuff = stuff + 10;
if (stuff) { do something; }
```

ASCII

- 7 bit ASCII includes printable and non-printable characters.

00	nul	10	dle	20	sp	30	0	40	@	50	P	60	`	70	p
01	soh	11	dc1	21	!	31	1	41	A	51	Q	61	a	71	q
02	stx	12	dc2	22	"	32	2	42	B	52	R	62	b	72	r
03	etx	13	dc3	23	#	33	3	43	C	53	S	63	c	73	s
04	eot	14	dc4	24	$	34	4	44	D	54	T	64	d	74	t
05	enq	15	nak	25	%	35	5	45	E	55	U	65	e	75	u
06	ack	16	syn	26	&	36	6	46	F	56	V	66	f	76	v
07	bel	17	etb	27	'	37	7	47	G	57	W	67	g	77	w
08	bs	18	can	28	(	38	8	48	H	58	X	68	h	78	x
09	ht	19	em	29	)	39	9	49	I	59	Y	69	i	79	y
0a	nl	1a	sub	2a	*	3a	:	4a	J	5a	Z	6a	j	7a	z
0b	vt	1b	esc	2b	+	3b	;	4b	K	5b	[	6b	k	7b	{
0c	np	1c	fs	2c	,	3c	<	4c	L	5c	\	6c	l	7c	|
0d	cr	1d	gs	2d	-	3d	=	4d	M	5d	]	6d	m	7d	}
0e	so	1e	rs	2e	.	3e	>	4e	N	5e	^	6e	n	7e	~
0f	si	1f	us	2f	/	3f	?	4f	O	5f	_	6f	o	7f	del

Control Characters

- The first 32 ASCII values are control characters
- They were originally intended not to carry printable information, but rather to control devices and communication.

Name	Hex	Purpose
LF	0A	Line feed, move paper down one line
BEL	07	Ring the bell
CR	0D	Carriage Return, move to beginning of line
SOH	01	Start Of Header for sending packets
DEL	7F	Delete previous character

Ancient Teletype Terminal

- An old teletype needed control for printing and paper tape.
- **`del`** punched holes over the previous character
- **`nul`** was used to give the printer time to physically move

Modern Inconsistencies

- The original standard for control characters was somewhat ambiguous.
- Different companies had different interpretations that persist to today.
- What is a new line character, **`'\n'`**?

Parity

- Early computer systems used only 7 bits for ASCII characters instead of the full byte.
- The Most Significant Bit was used for error detection in communications.
- The parity bit was set to the XOR of the data bits
- If the calculated parity bit was not the same as the received parity bit, an error has occurred.

7 bit ASCII	Parity bit	ASCII w/ parity
1010110	0	01010110
0001110	1	10001110

Unicode

- The ASCII character set only has 128 characters or 256 if all 8 bits are used.
- ASCII does not provide characters for other national languages, such as Japanese or Arabic.
- The Unicode character set has 16 bit characters
- The first 128 Unicode characters are the same as ASCII.

Other Character Sets

- IBM computers used to use the EBCDIC character set. It use 8 bits per character.
- Early Univac computer used the Fieldata character set. It used on 6 bits per character.

Characters and Fonts

- The bit pattern or number value of a character defines what the character should be. For example, 65 is an 'A'.
- Fonts define how a given character should be displayed on the screen. The character 'A' can be displayed as **A**, *A*, A, A, or 𝒜
- Changing the font changes how the character appears on the screen but does not change the value or meaning of the character.

Fonts

Serif (Minion Pro)
- Old Style (Adobe Jenson Pro)
- Transitional (ITC New Baskerville)
- Modern (Bodoni)

Slab Serif (Clarendon)

Sans serif (Myriad)

Script (Coronet)

Blackletter (Teutonic No. 1)

DISPLAY (LiquidCrystal)

Monospaced (Courier)

✤✻■✳✪❁▼ (ITC Zapf Dingbats)

(Dingbat)

Pre-Computer Printing

Flipped and Close Up

Origin of the word *Font*

- The term *font*, a cognate of the word *fondue*, derives from Middle French *fonte*, meaning "(something that has been) melt(ed)", referring to type produced by casting molten metal at a type foundry.

Font Terms

Points

- Fonts are traditionally measured in points.
- A point is 1/72 of an inch.
- Font size measures an invisible box which is typically a bit larger than the distance from the tallest ascender to the lowest descender.
- 12 point font is 1/6 of an inch

Font Sizes

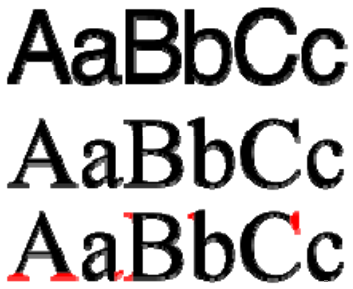
- Poster (extremely large sizes, usually larger than 72 point)
- Display (large sizes, typically 19-72 point)
- Subhead (large text, typically about 14-18 point)
- regular (typically about 10-13 point)
- Small text (typically about 8-10 point)
- Caption (very small, typically about 6-8 point)

Font Styles

- Most fonts come in four different styles
  - –Regular
  - –*Italic*
  - –**Bold**
  - –***Bold Italic***
- Different styles do not change the point size.

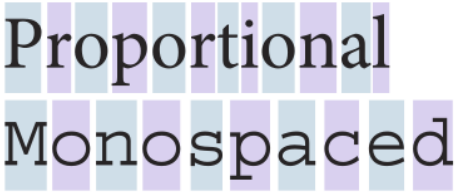
Serifs

- Serifs comprise the small features at the end of strokes within letters.
- Fonts without serifs are **sans serif**.



Proportional Fonts

- Not every letter is written as the same width.
- With proportional fonts some characters, like "W" are wider than others, like "i".
- Monospaced fonts function better for some purposes because they line up in neat, regular columns.



Strings

- In C++ and Java, a **`char`** variable can only hold one character.
- Strings are variables that can hold many characters.
- In C++ and Java, a character constant is surrounded by single quotes, 'A' while strings are surrounded by double quotes, "string"

Many Strings

- There are many ways to represent strings.
- The C language did not include a string type. Strings were stored in arrays of **`char`**
- C strings are terminated by a null character, the character whose numerical value is zero.
- The **`char`** array must be one longer than the maximum string size to hold the null terminator character.

Varying Length Strings

- C++ has several string classes.
- Java and C++ string classes allow strings to be as long as necessary (with a very large maximum).
- There is no visible terminating character is Java Strings