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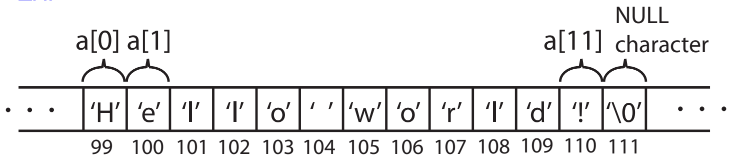
Strings and Arrays

- Recall from the lecture on Arrays that C represents strings as arrays of char:
  Ex: `char a[] = "Hello world!";`
- The compiler will store the string in an array of `char`s, and will append a null character ('\0') to the end of this array.
  Ex:



- String-related functions use the null character to determine when the end of a string has been reached.

Strings and Arrays

Recall our first C program:

```
#include <stdio.h>
main()
{
  printf("Hello World!\n");
}
```

which printed "Hello World" to the standard output (our terminal screen).

This program can be rewritten as:

```
#include <stdio.h>
main() {
  char a[] = "Hello World!\n";
  int i;
  for (i=0; a[i] != '\0'; i++)
    printf("%c", a[i]);
}
```

–or–

```
#include <stdio.h>
main() {
  char a[] = "Hello World!\n";
  printf("%s", a);
}
```

Very long strings

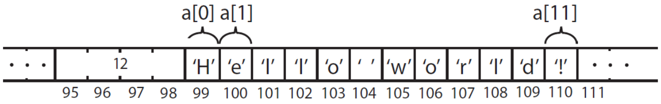
To make a string that is longer than the terminal width, without "wrap":

```
char a[] = "Hello World!\n"
    "But notice there is nothing but whitespace "
    "between the quote marks.  "
    "The compiler treats this as one very long string.";
```

Alternate layout for strings

- There is another way to lay out strings in memory, used by some other languages:
- The compiler will store the string in an array of `chars`, and will prepend an integer with value equal to the length of this array.

  Ex:



- Such strings can contain null bytes, making them useful for storing arbitrary binary data.

How to operate on strings, Version 1 (without pointers)

- The general approach to processing strings is to start with a well-chosen index, and increment the index until it references a null character:

```
...
char a[] = "Some string";
int i;
for (i=0; a[i] != '\0'; i++)
  printf("%c", a[i]);
...
```

Length of String vs. Size of char array

- The length of the string is the number of characters NOT INCLUDING the terminating null character

```
...
char a[] = "Some string";
int length = 0;
int size;
int i;
for (i=0; a[i] != '\0'; i++)
  length++;
printf("length(\"%s\") = %d\n", a, length);
size = sizeof(a)/sizeof(a[0]);
printf("size(\"%s\") = %d\n", a, size);
...
```

Getting strings from user

- Pass %s to scanf() just as with printf

```
...
char a[81];
printf("Enter a string:  ");
scanf("%s", a); // Note--no & here
...
```

- Input terminates on “whitespace”

Comparing strings

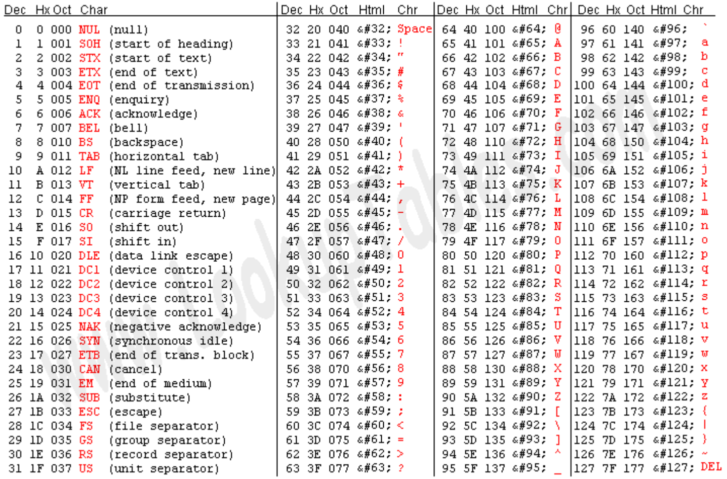
What is the correct "alphabetical order" of the following:

- abcde
- abcd
- Abcd

- Abcd
- abcd
- abcde

Comparing strings

C string comparisons and character comparisons are based on the American Standard Code for Information Interchange (ASCII):



Dec	Hx	Oct	Char		Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr
0	0	000	NUL	(null)	32	20	040	&#32;	Space	64	40	100	&#64;	@	96	60	140	&#96;	`
1	1	001	SOH	(start of heading)	33	21	041	&#33;	!	65	41	101	&#65;	A	97	61	141	&#97;	a
2	2	002	STX	(start of text)	34	22	042	&#34;	"	66	42	102	&#66;	B	98	62	142	&#98;	b
3	3	003	ETX	(end of text)	35	23	043	&#35;	#	67	43	103	&#67;	C	99	63	143	&#99;	c
4	4	004	EOT	(end of transmission)	36	24	044	&#36;	$	68	44	104	&#68;	D	100	64	144	&#100;	d
5	5	005	ENQ	(enquiry)	37	25	045	&#37;	%	69	45	105	&#69;	E	101	65	145	&#101;	e
6	6	006	ACK	(acknowledge)	38	26	046	&#38;	&	70	46	106	&#70;	F	102	66	146	&#102;	f
7	7	007	BEL	(bell)	39	27	047	&#39;	'	71	47	107	&#71;	G	103	67	147	&#103;	g
8	8	010	BS	(backspace)	40	28	050	&#40;	(	72	48	110	&#72;	H	104	68	150	&#104;	h
9	9	011	TAB	(horizontal tab)	41	29	051	&#41;	)	73	49	111	&#73;	I	105	69	151	&#105;	i
10	A	012	LF	(NL line feed, new line)	42	2A	052	&#42;	*	74	4A	112	&#74;	J	106	6A	152	&#106;	j
11	B	013	VT	(vertical tab)	43	2B	053	&#43;	+	75	4B	113	&#75;	K	107	6B	153	&#107;	k
12	C	014	FF	(NP form feed, new page)	44	2C	054	&#44;	,	76	4C	114	&#76;	L	108	6C	154	&#108;	l
13	D	015	CR	(carriage return)	45	2D	055	&#45;	-	77	4D	115	&#77;	M	109	6D	155	&#109;	m
14	E	016	SO	(shift out)	46	2E	056	&#46;	.	78	4E	116	&#78;	N	110	6E	156	&#110;	n
15	F	017	SI	(shift in)	47	2F	057	&#47;	/	79	4F	117	&#79;	O	111	6F	157	&#111;	o
16	10	020	DLE	(data link escape)	48	30	060	&#48;	0	80	50	120	&#80;	P	112	70	160	&#112;	p
17	11	021	DC1	(device control 1)	49	31	061	&#49;	1	81	51	121	&#81;	Q	113	71	161	&#113;	q
18	12	022	DC2	(device control 2)	50	32	062	&#50;	2	82	52	122	&#82;	R	114	72	162	&#114;	r
19	13	023	DC3	(device control 3)	51	33	063	&#51;	3	83	53	123	&#83;	S	115	73	163	&#115;	s
20	14	024	DC4	(device control 4)	52	34	064	&#52;	4	84	54	124	&#84;	T	116	74	164	&#116;	t
21	15	025	NAK	(negative acknowledge)	53	35	065	&#53;	5	85	55	125	&#85;	U	117	75	165	&#117;	u
22	16	026	SYN	(synchronous idle)	54	36	066	&#54;	6	86	56	126	&#86;	V	118	76	166	&#118;	v
23	17	027	ETB	(end of trans. block)	55	37	067	&#55;	7	87	57	127	&#87;	W	119	77	167	&#119;	w
24	18	030	CAN	(cancel)	56	38	070	&#56;	8	88	58	130	&#88;	X	120	78	170	&#120;	x
25	19	031	EM	(end of medium)	57	39	071	&#57;	9	89	59	131	&#89;	Y	121	79	171	&#121;	y
26	1A	032	SUB	(substitute)	58	3A	072	&#58;	:	90	5A	132	&#90;	Z	122	7A	172	&#122;	z
27	1B	033	ESC	(escape)	59	3B	073	&#59;	;	91	5B	133	&#91;	[	123	7B	173	&#123;	{
28	1C	034	FS	(file separator)	60	3C	074	&#60;	<	92	5C	134	&#92;	\	124	7C	174	&#124;	|
29	1D	035	GS	(group separator)	61	3D	075	&#61;	=	93	5D	135	&#93;	]	125	7D	175	&#125;	}
30	1E	036	RS	(record separator)	62	3E	076	&#62;	>	94	5E	136	&#94;	^	126	7E	176	&#126;	~
31	1F	037	US	(unit separator)	63	3F	077	&#63;	?	95	5F	137	&#95;	_	127	7F	177	&#127;	DEL

Reference: www.asciitable.com

Comparing strings

- Example:

```
// Return -1 if s1 < s2, 0 if s1 = s2, +1 if s1 > s2
int stringCompare(char s1[], char s2[])
{
  int i = 0;
  while (s1[i] && (s1[i] == s2[i]))
    i++;
  if (s1[i] < s2[i])
    return -1;
  else if (s1[i] > s2[i])
    return +1;
  else
    return 0;
}
```