

ASCII

Under the hood, C represents each **char** as an 8-bit *integer* (its "ASCII value").

- Uppercase letters are sequentially numbered
- Lowercase letters are sequentially numbered
- Digits are sequentially numbered
- Lowercase letters are 32 more than their uppercase equivalents (bit flip!)

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2	SP	!	"	#	\$	%	&	'	()	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[\]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{		}	~	DEL

Hexadecimal to ASCII conversion table

```
char uppercaseA = 'A';
```

```
// Actually 65
```

```
char lowercaseA = 'a';
```

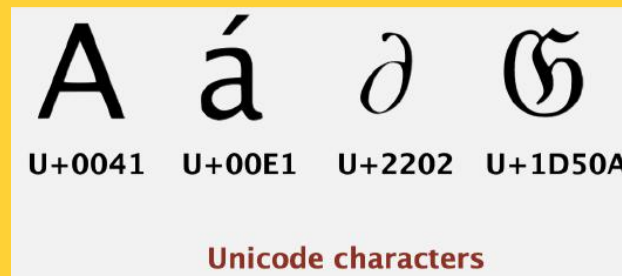
```
// Actually 97
```

```
char zeroDigit = '0';
```

```
// Actually 48
```

Unicode Transformation Formats

- The International Standards Organization's (ISO) 16-bit Unicode system can represent every character in every known language, with room for more
- Unicode being somewhat wasteful of space for English documents, ISO also defined several "Unicode Transformation Formats" (UTF), the most popular being UTF-8



ASCII

We can take advantage of C representing each **char** as an *integer*:

```
bool areEqual = 'A' == 'A';           // true
bool earlierLetter = 'f' < 'c';        // false
char uppercaseB = 'A' + 1;
int diff = 'c' - 'a';                  // 2
int numLettersInAlphabet = 'z' - 'a' + 1;
// or
int numLettersInAlphabet = 'Z' - 'A' + 1;
```

ASCII

We can take advantage of C representing each **char** as an *integer*:

```
// prints out every lowercase character
for (char ch = 'a'; ch <= 'z'; ch++) {
    printf("%c", ch);
}
```

Common ctype.h Functions

Function	Description
isalpha(<i>ch</i>)	true if <i>ch</i> is 'a' through 'z' or 'A' through 'Z'
islower(<i>ch</i>)	true if <i>ch</i> is 'a' through 'z'
isupper(<i>ch</i>)	true if <i>ch</i> is 'A' through 'Z'
isspace(<i>ch</i>)	true if <i>ch</i> is a space, tab, new line, etc.
isdigit(<i>ch</i>)	true if <i>ch</i> is '0' through '9'
toupper(<i>ch</i>)	returns uppercase equivalent of a letter
tolower(<i>ch</i>)	returns lowercase equivalent of a letter

Remember: these **return a char**; they cannot modify an existing char!

More documentation with `man isalpha`, `man tolower`

C Strings

C has no dedicated variable type for strings. Instead, a string is represented as an **array of characters** with a special ending sentinel value.

"Hello"	<i>index</i>	0	1	2	3	4	5
	<i>char</i>	'H'	'e'	'l'	'l'	'o'	'\0'

'\0' is the **null-terminating character**; you always need to allocate one extra space in an array for it.

String Length

Strings are **not** objects. They do not embed additional information (e.g., string length). We must calculate this!

index	0	1	2	3	4	5	6	7	8	9	10	11	12	13
value	'H'	'e'	'l'	'l'	'o'	','	' '	'w'	'o'	'r'	'l'	'd'	'!'	'\0'

We can use the provided **strlen** function to calculate string length. The null-terminating character does *not* count towards the length.

```
int length = strlen(myStr);           // e.g. 13
```

Caution: `strlen` is $O(N)$ because it must scan the entire string! We should save the value if we plan to refer to the length later.

Common string.h Functions

Function	Description
strlen(<i>str</i>)	returns the # of chars in a C string (before null-terminating character).
strcmp(<i>str1</i> , <i>str2</i>), strncmp(<i>str1</i> , <i>str2</i> , <i>n</i>)	compares two strings; returns 0 if identical, <0 if <i>str1</i> comes before <i>str2</i> in alphabet, >0 if <i>str1</i> comes after <i>str2</i> in alphabet. strncmp stops comparing after at most <i>n</i> characters.
strchr(<i>str</i> , <i>ch</i>) strrchr(<i>str</i> , <i>ch</i>)	character search: returns a pointer to the first occurrence of <i>ch</i> in <i>str</i> , or NULL if <i>ch</i> was not found in <i>str</i> . strrchr find the last occurrence.
strstr(<i>haystack</i> , <i>needle</i>)	string search: returns a pointer to the start of the first occurrence of <i>needle</i> in <i>haystack</i> , or NULL if <i>needle</i> was not found in <i>haystack</i> .
strcpy(<i>dst</i> , <i>src</i>), strncpy(<i>dst</i> , <i>src</i> , <i>n</i>)	copies characters in <i>src</i> to <i>dst</i> , including null-terminating character. Assumes enough space in <i>dst</i> . Strings must not overlap. strncpy stops after at most <i>n</i> chars, and <u>does not</u> add null-terminating char.
strcat(<i>dst</i> , <i>src</i>), strncat(<i>dst</i> , <i>src</i> , <i>n</i>)	concatenate <i>src</i> onto the end of <i>dst</i> . strncat stops concatenating after at most <i>n</i> characters. <u>Always</u> adds a null-terminating character.
strspn(<i>str</i> , <i>accept</i>), strcspn(<i>str</i> , <i>reject</i>)	strspn returns the length of the initial part of <i>str</i> which contains <u>only</u> characters in <i>accept</i> . strcspn returns the length of the initial part of <i>str</i> which does <u>not</u> contain any characters in <i>reject</i> .

The string library: `strcmp`

`strcmp(str1, str2)`: compares two strings.

- returns 0 if identical
- <0 if ***str1*** comes before ***str2*** in alphabet
- >0 if ***str1*** comes after ***str2*** in alphabet.

```
int compResult = strcmp(str1, str2);  
if (compResult == 0) {  
    // equal  
} else if (compResult < 0) {  
    // str1 comes before str2  
} else {  
    // str1 comes after str2  
}
```

Copying Strings – strcpy

We must make sure there is enough space in the destination to hold the entire copy, *including the null-terminating character*.

```
char str2[6];           // not enough space!  
strcpy(str2, "hello, world!"); // overwrites other memory!
```

Writing past memory bounds is called a “buffer overflow”. It can allow for security vulnerabilities!

char * vs. char[]

char myString[]

vs

char *myString

You can create char * pointers to point to any character in an existing string and reassign them since they are just pointer variables. You **cannot** reassign an array.

```
char myString[6];  
strcpy(myString, "Hello");  
myString = "Another string";  
---  
char *myOtherString = myString;  
myOtherString = somethingElse;
```

// not allowed!

// ok