

What is the difference between char array and char pointer in C?

Asked 9 years, 11 months ago Modified 1 year, 11 months ago Viewed 412k times

I am trying to understand pointers in C but I am currently confused with the following:

265

```
char *p = "hello"

This is a char pointer pointing at the character array, starting at h.

char p[] = "hello"

This is an array that stores hello.
```

What is the difference when I pass both these variables into this function?

```
void printSomething(char *p)
{
    printf("p: %s",p);
}
```

c arrays pointers

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edited Sep 13, 2019 at 12:43
Dan Grahm
8,508 ● 3 ● 36 ● 69

asked Apr 17, 2012 at 7:12
diesel
3,207 ● 4 ● 18 ● 16

This would not be valid: `char p[3] = "hello";` The initializer string is too long for the size of the array you declare. Typo? – Cody Gray ♦ Apr 17, 2012 at 7:17

Or just `char p[]="hello";` would suffice! – deepdive Jul 2, 2014 at 10:03

possible duplicate of C: differences between char pointer and array – sashoalm Feb 1, 2015 at 18:27

possible duplicate of What is the difference between char s[] and char *s in C? True, this also asks specifically about the function parameter, but that is not char specific. – Ciro Santilli Ilyrñep Kanyrt 六四事 Jun 5, 2015 at 7:44

you need to understand they are fundamentally different. the only commonality in this is that the base of the array p[] is a const pointer which enabled to access the array p[] via a pointer. p[] itself holds memory for a string, whereas *p just points to address of first element of just ONE CHAR (ie, points to the base of already allocated string). To better illustrate this, consider below: char *cPtr = {'h','e','l','l','o','\0'}; ==>this is an error,as cPtr is a pointer to only a character char cBuff[] = {'h','e','l','l','o','\0'}; ==>This is Ok, becos cBuff itself is a char array – llavarasan Oct 27, 2015 at 3:20

8 Answers

Active Oldest Votes

`char*` and `char[]` are different types, but it's not immediately apparent in all cases. This is because arrays decay into pointers, meaning that if an expression of type `char[]` is provided where one of type `char*` is expected, the compiler automatically converts the array into a pointer to its first element.

Your example function `printSomething` expects a pointer, so if you try to pass an array to it like this:

```
char s[10] = "hello";
printSomething(s);
```

The compiler pretends that you wrote this:

```
char s[10] = "hello";
printSomething(&s[0]);
```

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edited Apr 8, 2016 at 18:13
gsamaras
69.3k ● 39 ● 166 ● 276

answered Apr 17, 2012 at 7:15
Jon
410k ● 75 ● 713 ● 784

Is something changed from 2012 to now. For a character array "s" prints entire array., i.e., "hello" – Bhanu Tez May 9, 2019 at 6:48

@BhanuTez No, how data is stored and what is done with the data are separate concerns. This example prints the entire string because that is how `printf` handles the `%s` format string: start at the address provided and continue until encountering null terminator. If you wanted to print just one character you could use the `%c` format string, for example. – jacobq Jun 17, 2019 at 10:59

Just wanted to ask whether `char *p = "abc";` the NULL character `\0` is automatically appended as in case of `char []` array? – ajaysinghnegi Jul 8, 2019 at 17:53

why i can set `char *name; name="123";` but can do the same with `int` type? And after using `%c` to print `name` , the output is unreadable string: `0` ? – TomSawyer Apr 23, 2020 at 19:52

Let's see:

```
#include <stdio.h>
#include <string.h>

int main()
{
    char *p = "hello";
    char q[] = "hello"; // no need to count this

    printf("%zu\n", sizeof(p)); // => size of pointer to char -- 4 on x86, 8 on x86-64
    printf("%zu\n", sizeof(q)); // => size of char array in memory -- 6 on both

    // size_t strlen(const char *s) and we don't get any warnings here:
    printf("%zu\n", strlen(p)); // => 5
    printf("%zu\n", strlen(q)); // => 5

    return 0;
}
```

`foo*` and `foo[]` are different types and they are handled differently by the compiler (pointer = address + representation of the pointer's type, array = pointer + optional length of the array, if known, for example, if the array is statically allocated), the details can be found in the standard. And at the level of runtime no difference between them (in assembler, well, almost, see below).

Also, there is a related question in the C FAQ:

Q: What is the difference between these initializations?

```
char a[] = "string literal";
char *p = "string literal";
```

My program crashes if I try to assign a new value to p[].

A: A string literal (the formal term for a double-quoted string in C source) can be used in two slightly different ways:

1. As the initializer for an array of char, as in the declaration of char a[], it specifies the initial values of the characters in that array (and, if necessary, its size).

2. Anywhere else, it turns into an unnamed, static array of characters, and this unnamed array may be stored in read-only memory, and which therefore cannot necessarily be modified. In an expression context, the array is converted at once to a pointer, as usual (see section 6), so the second declaration initializes p to point to the unnamed array's first element.

Some compilers have a switch controlling whether string literals are writable or not (for compiling old code), and some may have options to cause string literals to be formally treated as arrays of const char (for better error catching).

See also questions 1.31, 6.1, 6.2, 6.8, and 11.8b.

References: K&R2 Sec. 5.5 p. 104

ISO Sec. 6.1.4, Sec. 6.5.7

Rationale Sec. 3.1.4

H&S Sec. 2.7.4 pp. 31-2

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edited Apr 18, 2012 at 7:00

answered Apr 17, 2012 at 8:44
JJJ
2,671 ● 10 ● 22

In sizeof(q), why doesn't q decay into a pointer, as @Jon mentions in his answer? – garyp Apr 21, 2016 at 19:23

@garyp q doesn't decay into a pointer because sizeof is an operator, not a function (even if sizeof was a function, q would decay only if the function was expecting a char pointer). – Grib Aug 14, 2016 at 17:07

thanks, but printf("%u\n" instead of printf("%zu\n" , I think you should remove z. – Zakaria Feb 17, 2018 at 20:11

What is the difference between char array vs char pointer in C?

C99 N1256 draft

There are two different uses of character string literals:

1. Initialize `char[]`:

```
char c[] = "abc";
```

This is "more magic", and described at 6.7.8/14 "Initialization":

An array of character type may be initialized by a character string literal, optionally enclosed in braces. Successive characters of the character string literal (including the terminating null character if there is room or if the array is of unknown size) initialize the elements of the array.

So this is just a shortcut for:

```
char c[] = {'a', 'b', 'c', '\0'};
```

Like any other regular array, `c` can be modified.

2. Everywhere else: it generates an:

- unnamed
- array of char [What is the type of string literals in C and C++?](#)
- with static storage
- that gives UB (undefined behavior) if modified

So when you write:

```
char *c = "abc";
```

This is similar to:

```
/* __unnamed is magic because modifying it gives UB. */
static char __unnamed[] = "abc";
char *c = __unnamed;
```

Note the implicit cast from `char[]` to `char *`, which is always legal.

Then if you modify `c[0]`, you also modify `__unnamed`, which is UB.

This is documented at 6.4.5 "String literals":

5 In translation phase 7, a byte or code of value zero is appended to each multibyte character sequence that results from a string literal or literals. The multibyte character sequence is then used to initialize an array of static storage duration and length just sufficient to contain the sequence. For character string literals, the array elements have type char, and are initialized with the individual bytes of the multibyte character sequence [...]

6 It is unspecified whether these arrays are distinct provided their elements have the appropriate values. If the program attempts to modify such an array, the behavior is undefined.

6.7.8/32 "Initialization" gives a direct example:

EXAMPLE 8: The declaration

```
char s[] = "abc", t[3] = "abc";
```

defines "plain" char array objects `s` and `t` whose elements are initialized with character string literals.

This declaration is identical to

```
char s[] = { 'a', 'b', 'c', '\0' },
t[] = { 'a', 'b', 'c' };
```

The contents of the arrays are modifiable. On the other hand, the declaration

```
char *p = "abc";
```

defines `p` with type "pointer to char" and initializes it to point to an object with type "array of char" with length 4 whose elements are initialized with a character string literal. If an attempt is made to use `p` to modify the contents of the array, the behavior is undefined.

GCC 4.8 x86-64 ELF implementation

Program:

```
#include <stdio.h>

int main(void) {
    char *s = "abc";
    printf("%s\n", s);
    return 0;
}
```

Compile and decompile:

```
gcc -g -gdwarf-5 -std=c99 -o main.o
objdump -S main.o
```

Output contains:

```
char *s = "abc";
8: 48 c7 45 f8 00 00 00    movq    $0x0,-0x8(%rbp)
f: 00 00 00 00 00 00 00 00
   0: R_X86_64_32S .rodata
```

Conclusion: GCC stores `char*` it in `.rodata` section, not in `.text`.

If we do the same for `char[]`:

```
char s[] = "abc";
```

we obtain:

```
17: c7 45 f8 61 62 63 00    movl    $0x636261,-0x10(%rbp)
```

so it gets stored in the stack (relative to `%rbp`).

Note however that the default linker script puts `.rodata` and `.text` in the same segment, which has execute but no write permission. This can be observed with:

```
readelf -l a.out
```

which contains:

```
Section to Segment mapping:
Segment Sections...
02      .text .rodata
```

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edited Sep 11, 2019 at 17:34
dev
383 ● 2 ● 17

answered Jun 5, 2015 at 7:45
Ciro Santilli Ilyrñep Kanyrt 六四事
294k ● 84 ● 1070 ● 870

@leszek.hanusz Undefined Behaviour stackoverflow.com/questions/2766731/... Google "C language UB"; -) – Ciro Santilli Ilyrñep Kanyrt 六四事 May 3, 2016 at 9:47

You're not allowed to change the contents of a string constant, which is what the first `p` points to. The second `p` is an array initialized with a string constant, and you can change its contents.

10

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edited May 12, 2017 at 23:15
Justin
22.7k ● 12 ● 90 ● 138

answered Apr 17, 2012 at 10:08
potrzebie
1,730 ● 1 ● 12 ● 25

For cases like this, the effect is the same: You end up passing the address of the first character in a string of characters.

The declarations are obviously not the same though.

The following sets aside memory for a string and also a character pointer, and then initializes the pointer to point to the first character in the string.

```
char *p = "hello";
```

While the following sets aside memory just for the string. So it can actually use less memory.

```
char p[10] = "hello";
```

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edited Mar 31, 2015 at 15:34

answered Apr 17, 2012 at 7:19
Jonathan Wood
61.6k ● 66 ● 243 ● 408

codeplusplus.blogspot.com/2007/09/09... "However, initializing the variable takes a huge performance and space penalty for the array" – leef Mar 10, 2013 at 14:22

@leef: I think that depends where the variable is located. If it's in static memory, I think it is possible for the array and data to be stored in the EXE image and not require any initialization at all. Otherwise, yes, it certainly can be slower if the data has to be allocated and then the static data has to be copied in. – Jonathan Wood Mar 31, 2015 at 15:34

From APUE, Section 5.14 :

```
char    good_template[] = "/tmp/dirXXXXXX"; /* right way */
char    *bad_template = "/tmp/dirXXXXXX";   /* wrong way*/
```

... For the first template, the name is allocated on the stack, because we use an array variable. For the second name, however, we use a pointer. In this case, only the memory for the pointer itself resides on the stack; the compiler arranges for the string to be stored in the read-only segment of the executable. When the `mkttemp` function tries to modify the string, a segmentation fault occurs.

The quoted text matches @Ciro Santilli 's explanation.

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answered Mar 6, 2019 at 10:24
Rick
5,907 ● 2 ● 35 ● 63

As far as I can remember, an array is actually a group of pointers. For example

```
p[i++] = *(&p+1)
```

is a true statement

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answered Apr 17, 2012 at 7:16
CosminO
4,752 ● 6 ● 25 ● 48

I would describe an array as being a pointer to the address of a block of memory. Hence why `*(&arr + 1)` points you to the second member of `arr`. If `*(&arr)` points to a 32-bit memory address, e.g. `bfbcdf5e`, then `*(&arr + 1)` points to `bfbcdf60` (the second byte). Hence why going out of the scope of an array will lead to weird results if the OS doesn't segfault. If `int a = 24;` is at address `bfbcdf62`, then accessing `arr[2]` might return `24`, assuming a segfault doesn't happen first. – Braden Best Feb 5, 2014 at 3:05

`char p[3] = "hello"` ? should be `char p[6] = "hello"` remember there is a `\0` char in the end of a "string" in C.

anyway, array in C is just a pointer to the first object of an adjust objects in the memory, the only different s are in semantics. while you can change the value of a pointer to point to a different location in the memory an array, after created, will always point to the same location. also when using array the "new" and "delete" is automatically done for you.

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edited Apr 17, 2012 at 7:33

answered Apr 17, 2012 at 7:19
Roe Gavriel
18k ● 12 ● 59 ● 88