

Arrays and Strings

CS 2022: Introduction to C

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(based on slides by Saikat Guha)

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Announcement

- ▶ Assignment #1 released
 - ▶ due this Friday Sept. 11th at 11:59 PM
 - ▶ submit via CMS
- ▶ Reminder: office hours today after class in 4139 Upson Hall

Arrays

- ▶ Contiguous memory
- ▶ Type is same as element-pointer
 - ▶ Accessing array elements is syntactic sugar for pointer arithmetic
- ▶ On the stack
 - ▶ Fixed-size (at compile time)
 - ▶ Compiler allocates
 - ▶ Compiler deallocates
- ▶ On the heap
 - ▶ Variable size (malloc)
 - ▶ Explicit allocation/deallocation

Declaring Arrays

```
void foo(int x) {  
    int a[100];  
    int b[] = {0, 1, 0, 2, 3, 1};  
    int c[x]; // ERROR: Size must be const.  
  
    a[0] = 10;  
    a[5] = b[2];  
    a[100] = 10; // ERROR: Clobbering stack!!  
  
    *(a + 1) = 20;    // same as a[1] = 20;  
    *b = *(a + 5);   // same as b[0] = a[5];  
}
```

Declaring Arrays

```
void foo(int x) {  
    int *a = malloc(x * sizeof(int));  
  
    a[0] = 10;        // same as *a = 10;  
    a[1] = a[0];     // same as *(a+1) = *a;  
  
    free(a);  
}
```

Library Functions

- ▶ `#include <string.h>`
- ▶ Set all elements to 0:
`memset(array, 0, bytes)`
- ▶ Copy elements:
`memcpy(dst, src, bytes)`
- ▶ Note: `bytes = number of elements * sizeof(int)`
for integer arrays.

Array Problems

- ▶ No array-bound checks. No warnings.
- ▶ Can clobber stack or heap
- ▶ **especially** with array-to-array copy when the destination array doesn't have enough space.
- ▶ `sizeof(array)` is number of *bytes* when exact size can be determined; 4 when size cannot be determined at compile time and is treated as a pointer. Avoid.

Characters

- ▶ Type for character: `char`
- ▶ 1-byte in size
- ▶ Enclosed in single-quotes
- ▶ `printf` format: `%c`
- ▶ ASCII character
 - ▶ Alpha: `'a'`
 - ▶ Digit: `'4'`
 - ▶ Special: `'\t'`
 - ▶ Null: `'\0'`
- ▶ `wchar_t` for unicode characters

Strings

- ▶ String: `char *` or `char []`
- ▶ Enclosed in double-quotes
- ▶ Terminated by Null character (`'\0'`)
- ▶ "Hello"
- ▶ printf format: `%s`
- ▶ same as

```
char str[] = {'H', 'e', 'l', 'l',  
             'o', '\0'}
```
- ▶ `(str + 5)`: type is `char *`; substring starting at 5th character
- ▶ `*(str + 5)` or `str[5]` – the 5th character

Library Functions

- ▶ `#include <string.h>`
- ▶ All string library functions expect null-terminated strings.
- ▶ When joining/copying/splitting strings, library inserts null-character where appropriate.

Library Functions

- ▶ `strlen(s)` – Length
- ▶ `strncpy(dst, src, n)`
Copies 'n' characters from `src` to `dst` (incl. `'\0'`)
- ▶ `strncat(dst, src, n)`
Copies characters from `src` to end of `dst` until `dst` has 'n' characters (incl. `'\0'`)
- ▶ `int strcmp(char *s1, char *s2)`
Compares strings. Returns 0 when strings **are equal**.
Positive when `s1` greater, negative when `s1` smaller.
ASCII order.

Note: Cannot use `==` to check string equality since it compares pointers. Points to two different copies of the same string will be different.

Library Functions

- ▶ `char *strstr(char *haystack, char *needle)`
Search for a substring in a string
- ▶ `char *strdup(char *str)`
Allocates space on the heap (with `malloc`) and copies the argument into the allocated space. **Caller MUST free** the returned string when done.
- ▶ `char *strtok_r(char *str, char *delim, char **sav)`
Used to break apart a string into pieces. See man-page for details.

Multi-Dimensional Arrays

```
void foo(void) {  
    int a[3][5];  
    int b[7][3][6];  
  
    a[1][2] = 10; // same as *(a + 1*5 + 2) = 10  
    b[1][2][3] = 5; // same as *(b + 1*18 + 2*6 + 3)=5  
}
```

Arrays of Strings

- ▶ `char **` or `char *a[]`
- ▶ e.g. command-line arguments
- ▶ `a[0]` is a string (type `char *`)