CS107, Lecture 10

Arrays and Pointers, Take II

Reading: K&R (5.2-5.5) or Essential C section 6

Ed Discussion: https://edstem.org/us/courses/28214/discussion/1959584

Based on slides created by Cynthia Lee, Chris Gregg, Nick Troccoli, Lisa Yan, Jerry Cain and others.

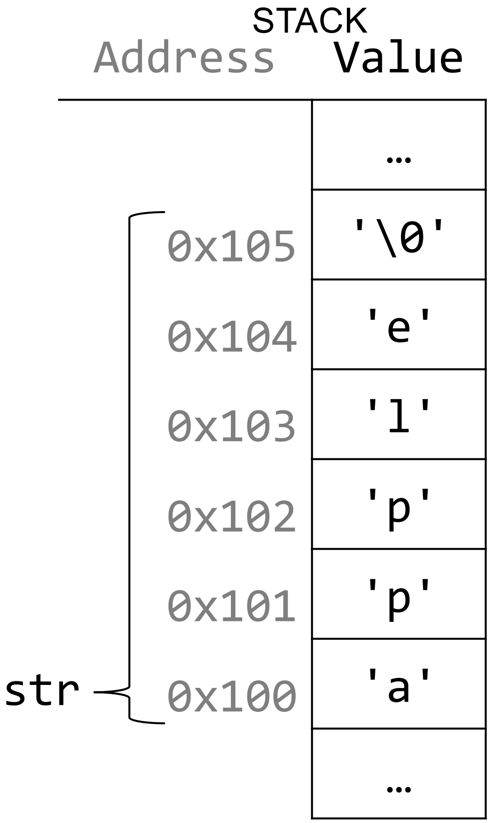
Arrays

When you declare an array, contiguous memory is allocated on the stack to store the contents of the entire array.

```
char str[6];
strcpy(str, "apple");
```

The array variable (e.g. **str**) is not a pointer; it refers to the entire array contents. In fact, **sizeof** returns the size of the entire array!

```
size_t arrayBytes = sizeof(str); // 6
```



STACK

	Address	Value
		…
	0x105	'\0'
	0x104	'e'
	0x103	'l'
	0x102	'p'
	0x101	'p'
str	0x100	'a'
		…

Arrays

An array variable refers to an entire block of memory. You cannot reassign an existing array to be equal to a new array.

```
int nums[] = {1, 2, 3};
int nums2[] = {4, 5, 6, 7};
nums = nums2; // not allowed!
```

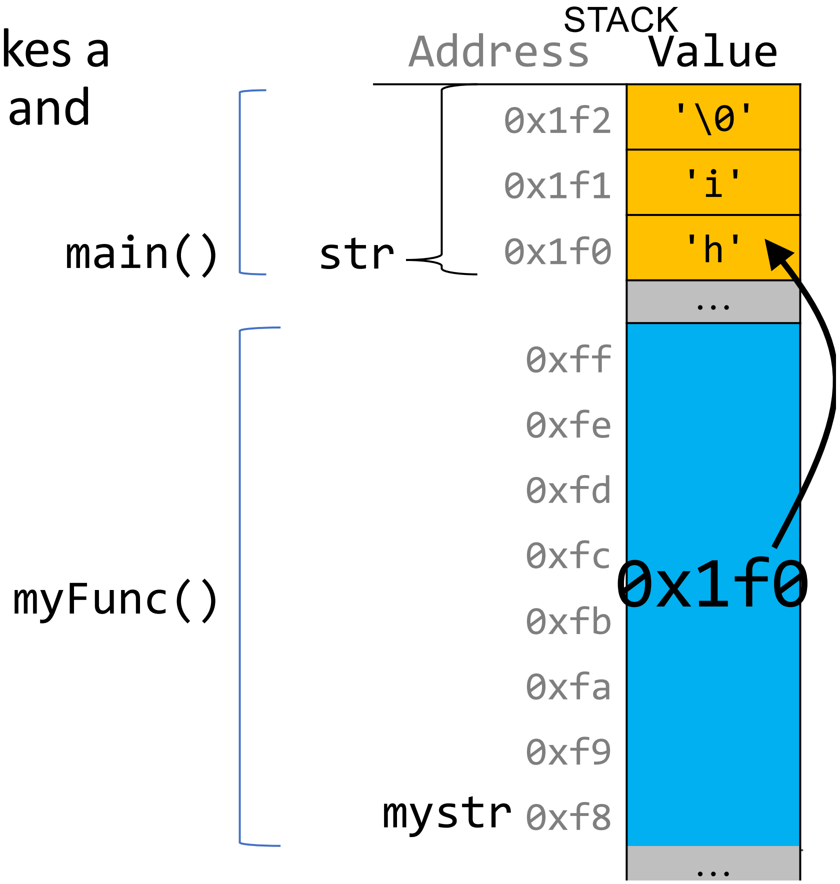
An array's size cannot be changed once you create it. You must create another new array instead.

Arrays as Parameters

When you pass an **array** as a parameter, C makes a *copy of the address of the first array element*, and passes it (a pointer) to the function.

```
void myFunc(char *myStr) {
     ...
}

int main(int argc, char *argv[]) {
     char str[3];
     strcpy(str, "hi");
     myFunc(str);
     ...
}
```

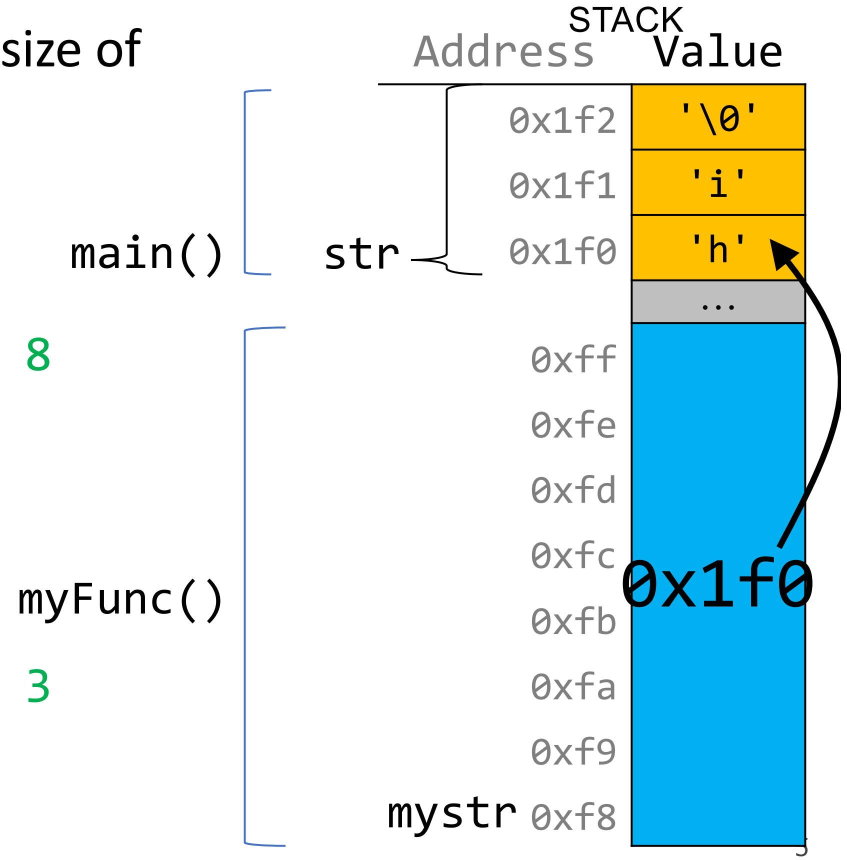


Arrays as Parameters

This also means we can no longer get the full size of the array using **sizeof**, because now it is just a pointer.

```
void myFunc(char *myStr) {
     size_t size = sizeof(myStr); // 8
}

int main(int argc, char *argv[]) {
     char str[3];
     strcpy(str, "hi");
     size_t size = sizeof(str);   // 3
     myFunc(str);
     ...
}
```



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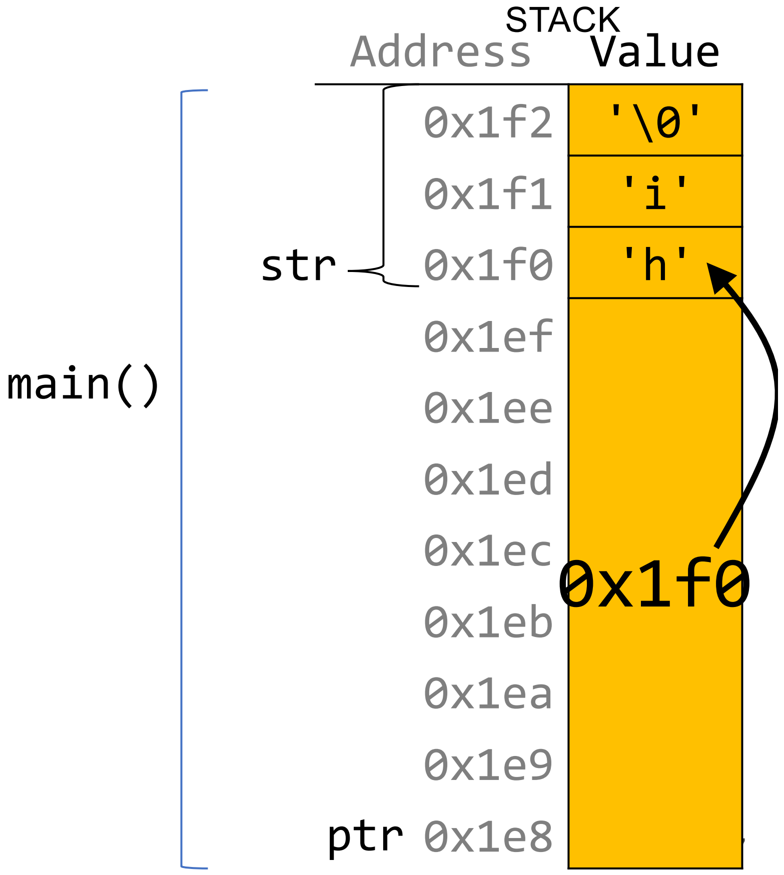
		Address	Value
main()		0x1f2	'\0'
		0x1f1	'i'
	str	0x1f0	'h'
			...
myFunc()		0xff	0x1f0
		0xfe	
		0xfd	
		0xfc	
		0xfb	
		0xfa	
		0xf9	
	mystr	0xf8	

sizeof returns the size of an array, or 8 for a pointer. Therefore, when we pass an array as a parameter, we can no longer use **sizeof** to get its full size.

Arrays and Pointers

You can also make a pointer equal to an array; it will point to the first element in that array.

```
int main(int argc, char *argv[]) {
     char str[3];
     strcpy(str, "hi");
     char *ptr = str;
     ...
}
```



STACK

		Address	Value
main()		0x1f2	'\0'
		0x1f1	'i'
	str	0x1f0	'h'
		0x1ef	
		0x1ee	
		0x1ed	
		0x1ec	
		0x1eb	0x1f0
		0x1ea	
		0x1e9	
	ptr	0x1e8	

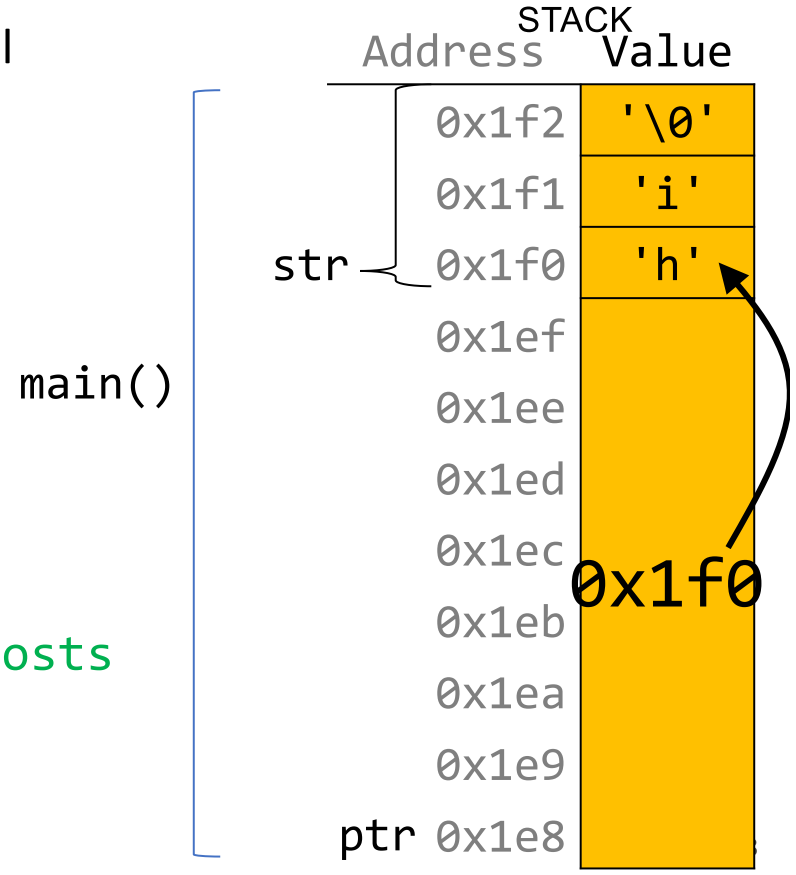
Arrays and Pointers

You can also make a pointer equal to an array; it will point to the first element in that array.

```
int main(int argc, char *argv[]) {
     char str[3];
     strcpy(str, "hi");
     char *ptr = str;

     // equivalent
     char *ptr = &str[0];

     // equivalent, but avoid at all costs
     char *ptr = &str;
     ...
}
```



Pointer Arithmetic

When you do pointer arithmetic, you are adjusting the pointer by a certain *number of places* (e.g., characters).

```
char *str = "apple";    // e.g. 0xff0
char *str1 = str + 1;   // e.g. 0xff1
char *str3 = str + 3;   // e.g. 0xff3

printf("%s", str);      // apple
printf("%s", str1);     // pple
printf("%s", str3);     // le
```

DATA SEGMENT

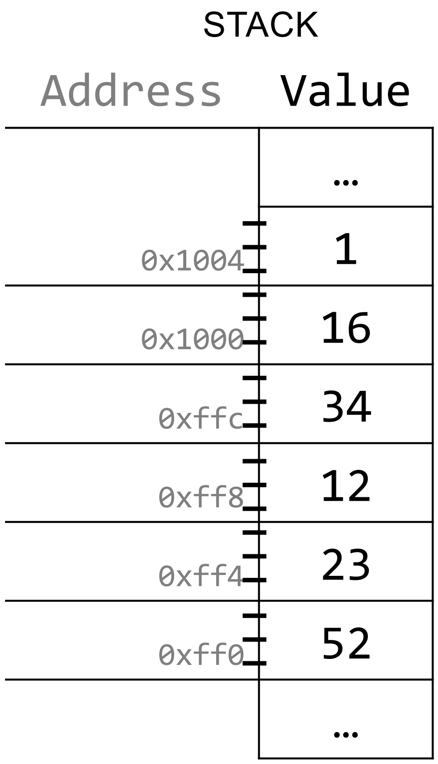
Address	Value
	…
0xff5	'\0'
0xff4	'e'
0xff3	'l'
0xff2	'p'
0xff1	'p'
0xff0	'a'
	…

Pointer Arithmetic

Pointer arithmetic does *not* work in bytes. Instead, it works in the *size of the type it points to*.

```
// nums points to an int array
int *nums = …              // e.g. 0xff0
int *nums1 = nums + 1;  // e.g. 0xff4
int *nums3 = nums + 3;  // e.g. 0xffc

printf("%d", *nums);    // 52
printf("%d", *nums1);   // 23
printf("%d", *nums3);   // 34
```



STACK

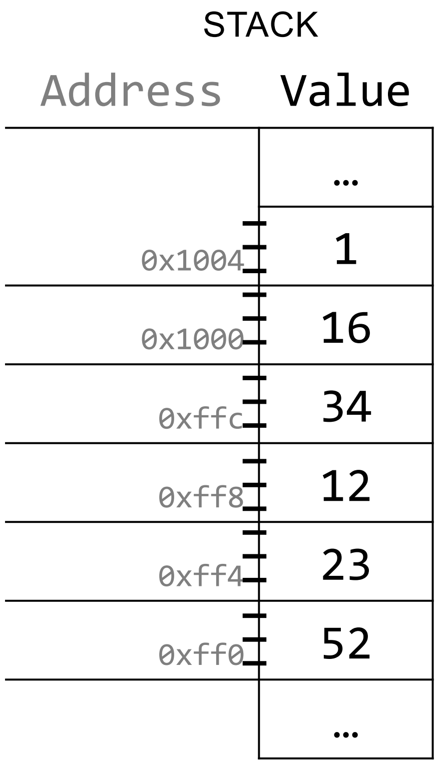
Address	Value
	…
0x1004	1
0x1000	16
0xffc	34
0xff8	12
0xff4	23
0xff0	52
	…

Pointer Arithmetic

Pointer arithmetic does *not* work in bytes. Instead, it works in the *size of the type it points to*.

```
// nums points to an int array
int *nums = …              // e.g. 0xff0
int *nums3 = nums + 3;     // e.g. 0xffc
int *nums2 = nums3 - 1;    // e.g. 0xff8

printf("%d", *nums);       // 52
printf("%d", *nums2);      // 12
printf("%d", *nums3);      // 34
```



STACK

Address	Value
	…
0x1004	1
0x1000	16
0xffc	34
0xff8	12
0xff4	23
0xff0	52
	…

Pointer Arithmetic

When you use bracket notation with a pointer, you are actually *performing pointer arithmetic and dereferencing*:

```
char *str = "apple";    // e.g. 0xff0

// both of these add two places to str,
// and then dereference to get the char there.
// E.g. get memory at 0xff2.
char thirdLetter = str[2];        // 'p'
char thirdLetter2 = *(str + 2);  // 'p'
```

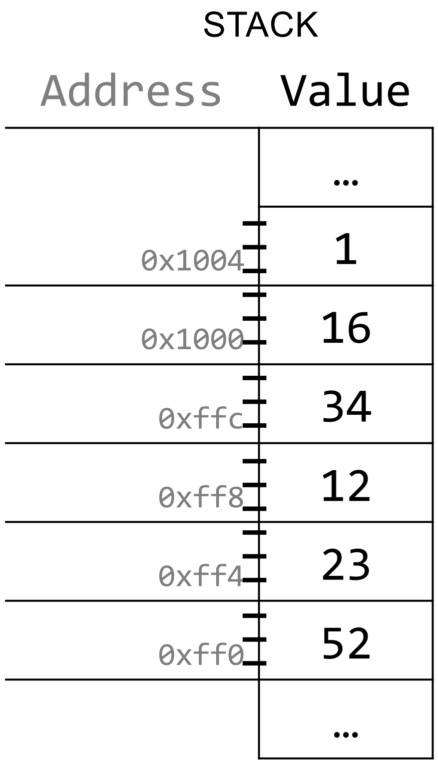
DATA SEGMENT

Address	Value
	…
0xff5	'\0'
0xff4	'e'
0xff3	'l'
0xff2	'p'
0xff1	'p'
0xff0	'a'
	…

Pointer Arithmetic

Pointer arithmetic with two pointers does *not* give the byte difference. Instead, it gives the number of *places* they differ by.

```
// nums points to an int array
int *nums = …                // e.g. 0xff0
int *nums3 = nums + 3;       // e.g. 0xffc
int diff = nums3 - nums;     // 3
```



STACK

Address	Value
	…
0x1004	1
0x1000	16
0xffc	34
0xff8	12
0xff4	23
0xff0	52
	…