CSE 333 Section 1 - C, Pointers, and Gitlab

Welcome to section!!!

Pointers

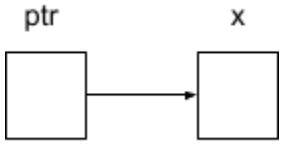
Pointers are a data type that store a memory address. We use them for a number of things in C, such as:

- Simulating "pass-by-reference"
- Using function arguments as return values (also known as "**output parameters**")
- Avoiding copying whole data structures when passing arguments into functions

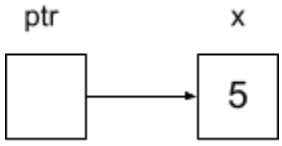
If we have a variable `x`, then `&x` will give us the address of `x`. If we have a pointer `p`, `*p` will give us the value stored at the address `p` is holding, or "the value `p` points to."

Let's look at an example!

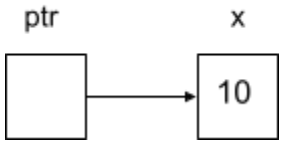
```
int x;
int *ptr;
ptr = &x;
x = 5;
*ptr = 10;
```



1) We can represent the result of the above three lines of code graphically. `ptr` stores the address of `x`. It "points to `x`." `x` currently doesn't have a value because we did not assign it one!



2) After executing `x = 5`, our diagram changes.



3) After executing, `*ptr = 10`, our diagram changes again. Notice that `x` has been modified by dereferencing `ptr`.

Output Parameters

Pointers let us modify the parameters we pass in (more precisely, we can modify the data our argument points to). This leads us to a special kind of parameter known as an **output parameter**. As the name suggests, this refers to a parameter that we use to store an output of a function. These are very common in C and you will see a lot of library functions that use these.

Exercise 1:
Consider the following snippet of code.

```
void division(int  numerator,
              int  denominator,
              int* quotient,
              int* remainder) {
  *quotient = numerator / denominator;
  *remainder = numerator % denominator;
}

int main(int argc, char* argv[]) {
  int quot, rem;
  division(22, 5, _____, _____);
  printf("%d rem %d\n", _____, _____);
  return EXIT_SUCCESS;
}
```

Which parameters are output parameters?

What variables should go in the blank spaces in our call to division()?

What should go in the blank spaces in our call to printf()?

Draw out a memory diagram of the beginning of this call to division().

Exercise 2:
The following code has a bug. What's the problem, and how would you fix it?

```
void bar(char ch) {
  ch = '3';
}

int main(int argc, char* argv[]) {
  char fav_class[] = "CSE331";
  bar(fav_class[5]);
  printf("%s\n", fav_class);  // should print "CSE333"
  return EXIT_SUCCESS;
}
```

Git

CSE 333 Git setup and tutorial:
https://courses.cs.washington.edu/courses/cse333/23wi/gitlab/

Common commands:

- `git clone <repo url>`
  - Downloads ("clones") your repo from GitLab.
- `git status`
  - Prints the status of your repo (*e.g.* changes that need to be committed).
- `git add <list of files/directories>`
  - Stages a file to be committed to the repo. Note that "`git add .`" will stage any changes in the current directory and subdirectories you have made since your last commit.
- `git commit -m "<commit message>"`
  - Commits changes to your repo.
- `git push`
  - Pushes commits to GitLab from your local machine.
- `git pull`
  - Pulls changes from GitLab to your local machine.
- `git tag <tag>`
  - Puts a tag on your repo to indicate some important event (for this class, to indicate a completed homework submission). Note that you have to push tags to GitLab much like you would a commit.

Exercise 3 (bonus):

`strcpy` is a function from the standard library that copies a string `src` into an output parameter called `dest` and returns a pointer to the beginning of the destination string. Write the function below. You may assume that `dest` has sufficient space to store `src`.

```
char* strcpy(char* dest, char* src) {




}
```

How is the caller able to see the changes in `dest` if C is pass-by-value?

Why do we need an output parameter? Why can't we just return an array we create in strcpy?

Exercise 4 (bonus):
More practice with output parameters and arrays.

Write a function to compute the sum of values and product of all values in an array. The function is given a pointer to the first element in an array, the length of the array, and two output parameters to return the product and sum.

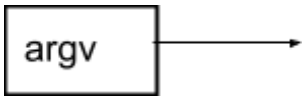
```
void product_and_sum(int* input, int length, int* product,
                     int* sum) {









}
```

Pointer Arithmetic and Arrays

We can do addition and subtraction to pointers, with a catch. Arithmetic on pointers is scaled to the size of the type being pointed to (in bytes). So, in the above example, `ptr + 1` would actually increase the value of `ptr` by 4 since it points to a 32-bit integer.

Arrays and pointers are very closely related. Array subscript notation is just special syntax for pointer arithmetic with `arr[i]` being equivalent to `*(arr + i)`. Using an array name in an expression returns the address of the first element in the array.

Exercise 4 (Bonus):
Given the following command: "`mkdir -v cats dogs`" and `argv = 0x1000`, draw a box-and-arrow memory diagram of `argv` and its contents for when `mkdir` executes.



Using the same information from above, what can you say about the values returned by the following expressions? You may not be able to tell the exact value returned, but you should be able to describe what that value is/represents.

```
1) argv[0]

2) argv + 1

3) *(argv[1] + 1)

4) argv[0] + 1

5) argv[0][3]
```

Exercise 5 (bonus):
A prefix sum over an array is the running total of all numbers in the array up to and including the current number. For example, given the array {1, 2, 3, 4}, the prefix sum would be {1, 3, 6, 10}.

Write a function to compute the prefix sum of an array given a pointer to its first element, the pointer to the first element of the output array, and the length of both arrays (assumed to be the same).

```
void prefix_sum(int* input, int* output, int length) {




}
```