Hack 7.0

Computer Science I

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Introduction

Hack session activities are small weekly programming assignments intended to get you started on full programming assignments. You may complete the hack on your own, but you are *highly encouraged* to work with another student and form a hack pair. Groups larger than 2 are not allowed. However, you may discuss the problems *at a high level* with other students or groups. You may not share code directly.

If you choose to form a Hack Pair, you *must*:

1. Both join a hack pair on Canvas (go to People then Hack Pairs)
2. You must both work on the hack equally; it must be an equal effort by both partners. Do not undermine your partner's learning opportunity and do not undermine your own by allowing one parter to do all the work.
3. Turn in only one copy of the code under the individual whose last name comes first (with respect to Canvas).

You are graded based on style, documentation, design and correctness. For detail, see the general course rubric.

Category	Point Value
Style	2
Documentation	2
Design	5
Correctness	16
Total	**25**

Table 1: Rubric

Correctness:

- 8 points on the array part, 2 for the first test suite, 6 for the second
- 8 points for the image part, 2 points for each test suite all proportional

Exercises

To get more practice working with arrays, you will write several functions that involve operations on arrays. In particular, implement the following functions.

1. Write a function that, given an integer array and an integer x determines if the array contains x anywhere within the array. It should return true if it does, false otherwise.

   ```
   int contains(const int *arr, int size, int x);
   ```

2. Write a function that, given an integer array and an integer x, determines if the array contains x within the range of the two provided indices i *and* j (including both indices). It should return true if it does, false otherwise.

   ```
   int containsWithin(const int *arr, int size, int x, int i, int j);
   ```

3. Write a function that, given an array of integers, its size and a "new size" creates a new deep copy of the array. However, instead of its original size, the new array should be of the new size. If the new size is less than the old size, only the first `newSize` elements should be copied over. If the new size is greater than the original size, then the new array should be padded out with zeros.

   ```
   int * paddedCopy(const int *arr, int oldSize, int newSize);
   ```

4. Write a function that, given an array of integers and its size, reverses the elements in the array. For example, if the original array was `[10, 15, 5, 25, 0]` the new array should be `[0, 25, 5, 15, 10]`.

   ```
   void reverse(int *arr, int size);
   ```

5. Write a similar function that creates and returns a new copy of the given array but with its elements in reverse order.

   ```
   int * reverseCopy(const int *arr, int size);
   ```

Image Manipulation

You'll get more practice with 2-dimensional arrays by writing several functions to manipulate images. We've adapted a C image library, the "stb" library, and written several *wrapper functions* to load and save images. Wrapper functions are functions that call other functions but may have some "glue code" to make the control flow or data com-

patible. In this case, our wrapper functions convert/translate the stb library's image representation into an RGB pixel representation. We've defined a `Pixel` structure that holds 3 integer values one for each of the red, green, and blue color values. We'll cover structures in detail later on, but it won't prevent you from working with them.

You can declare and use a `Pixel` type like you would an `int` or `double`:

```
1  //a single pixel:
2  Pixel p;
3  //an array of n pixels:
4  Pixel *p = (Pixel *) malloc(sizeof(Pixel) * n);
5
6  //swap two pixels:
7  Pixel a, b;
8  ...
9  Pixel temp = a;
10 a = b;
11 b = temp;
```

An $h \times w$ (height by width) image can be represented as a two dimensional array of `Pixel` types; in particular: `Pixel **image`. Everything we've covered using two dimensional arrays of `int` types applies to `Pixel` types.

We've provided a library of functions to load and save a file (you'll need to RTM) and specified several function signatures for functions you need to implement.

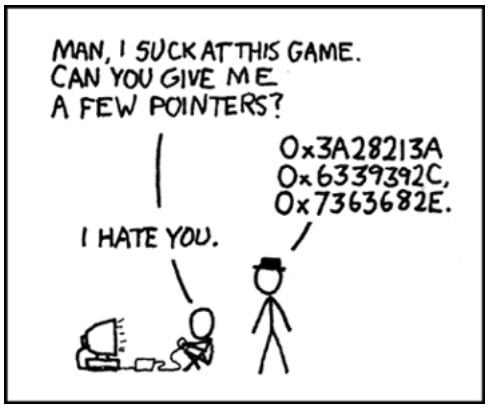
- `copyImage()` should produce a deep copy of the given image.
- `flipHorizontal()` should flip the image horizontally as depicted in Figure 1b.
- `flipVertical()` should flip the image vertically as depicted in Figure 1c.
- `rotateClockwise()` should produce a new image that is rotated 90 degrees clockwise. This function must produce a new image because an $h \times w$ sized image that has been rotated will be a $w \times h$ image. This operation is depicted in Figure 1d.

Instructions

- We have provided some starter code in the following project that you can clone:

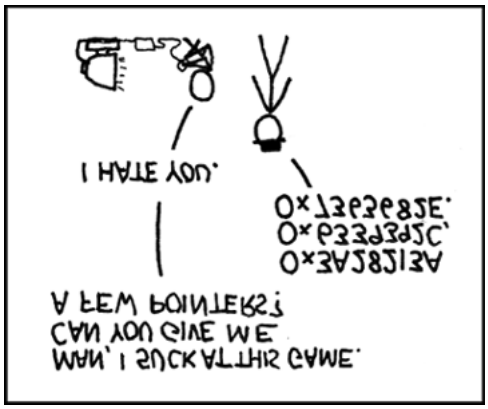
  https://github.com/cbourke/CSCE155-Hack7.0

- For the warm-up, place all your function prototypes into a file named `array_utils.h` and and their definitions in a file named `array_utils.c`. You will need to turn these in via webhandin.

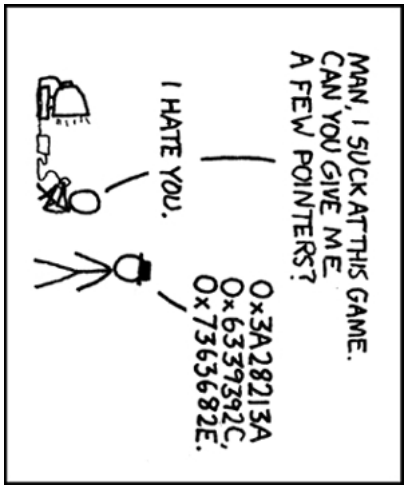


(a) Original Image

(b) Flipped Horizontally



(c) Flipped Vertically



(d) Rotated Clockwise

Figure 1: Manipulated Images

- You'll want to rigorously test your functions to verify they are correct. We've provided a starter test file, `arrayUtilsTester.c` that you can use. You do not need to hand in this file.
- All functions should perform reasonable error checks and handling even though they are not returning error codes. Ex: an invalid array cannot possibly hold an element x; functions that return a pointer can only return `NULL` for an error.
- You should test all your functions with an image using the image driver program we've provided.
- You should write/add documentation to all your functions *first*. Use this as an opportunity to think/discuss how the functions should work and to *whiteboard* your designs and solutions with other students.
- You are encouraged to collaborate any number of students before, during, and after your scheduled hack session.
- You may (in fact are encouraged) to define any additional "helper" functions that may help you.
- Include the name(s) of everyone who worked together on this activity in your source file's header.
- Turn in the following files to the webhandin, making sure that it runs and executes correctly in the webgrader. Each individual student will need to hand in their own copy and will receive their own individual grade.
  - `array_utils.h`
  - `array_utils.c`
  - `imageUtils.h`
  - `imageUtils.c`