

## Assignment 0: C Lab

Due: Tuesday, January 24, 2023 at 11:59pm PT

The purpose of this lab is to introduce you to the C language and to give you additional practice with data representations in C.

In many ways, the C language is like Java. The syntax for variable and function declarations, assignment statements, `for` and `while` loops, and `if`-statements are the same in both languages. The big difference is that in C we have a different view of data, one that is closer to the actual hardware. We must be aware of where in memory values are located and how much space they occupy. The exercises in this laboratory assignment will give you practice in thinking about variables, pointers, and structs—and how they relate to addresses and values in memory.

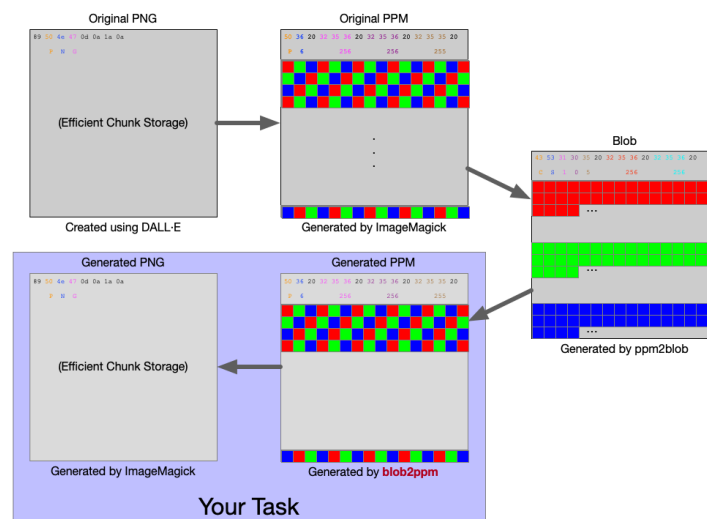
As with future labs, you should work in teams of two. Your partner will be assigned for this assignment.

## 1 Overview

For this assignment, you will write code that converts a provided file into an image. You will

1. login to the server (using ssh or the Visual Studio Code Remote - SSH extension)
2. create a new C program that converts a blob of data into a PPM file, and
3. then use ImageMagick to convert the PPM into a PNG.

The following diagram shows the process by which the blob was created and the process that you'll need to complete (you will need to write code for `blob2ppm`). As shown in the diagram, a PPM file stores image pixels in an alternating red-green-blue-red-green-blue... format. The `ppm2blob` tool used to create the blob converts this into a red-red-red...green-green-green...blue-blue-blue format; it also changes the file header.



## 2 Logging into the Server

If you are not on Pomona's WiFi or Ethernet, you will first need to connect to the Pomona VPN. If you do not already have the Pomona VPN set up on your machine, there are instructions for how to set-up the VPN here: <https://servicedesk.pomona.edu/support/solutions/articles/18000021757>

Once you are on Pomona's network, you should ssh into the course VM using the following command and your Pomona CAS username and password

```
ssh USERNAME@itbdcv-lnx04p.campus.pomona.edu
```

You can alternatively use Visual Studio Code and the Remote - SSH extension to access the server. If you are a VS Code person, you can download the extension here: <https://marketplace.visualstudio.com/items?itemName=ms-vscode-remote.remote-ssh>

## 3 Accessing the Starter Files

Starter code is available on the server. Use the following commands to make a copy of the starter code.

```
# make sure you are in your account's home directory
cd ~
```

```
# Copy and unpack the starter code into your account's home directory
tar xvf /cs105/starters/clab.tar
```

```
# Navigate into the new directory you just unpacked
cd clab
```

```
# Check which files got unpacked into that directory
ls
```

You should now have the following files in a directory named clab

- `image.blob`: this is the blob file that you need to convert to a PPM (and then a PNG)
- `ppm2blob.c`: The program used to convert the original PPM into a blob (you should reference this file when you get stuck)

## 4 Converting the blob to a PPM image

Your first task is to write a C program named `blob2ppm.c` that converts the made-up blob file into a valid PPM file (a simple, inefficient format for storing an image). Here are the steps involved:

1. Open the image.blob file with `fopen` (<https://en.cppreference.com/w/c/io/fopen>)
2. Read the header (all non-pixel data) of the blob file with `fscanf` (<https://en.cppreference.com/w/c/io/fscanf>)
3. Allocate space for three arrays of values (red, green, and blue pixel data) using `malloc` (<https://en.cppreference.com/w/c/memory/malloc>). Note: for the purposes of this assignment, **you must use malloc** (aka dynamically allocate memory on the heap), you may not statically allocate it on the stack.
4. Store data from the file into the three arrays with `fread` (<https://en.cppreference.com/w/c/io/fread>). Note: for the purposes of this assignment, **you must use pointers and pointer dereferencing** to access the memory allocated by `malloc`, you may not use array indexing to access that memory (even though, in real life, you could).
5. Close the blob file with `fclose` (<https://en.cppreference.com/w/c/io/fclose>)
6. Open/create the image.ppm file with `fopen`.
7. Write the PPM header with `fprintf` (<https://en.cppreference.com/w/c/io/fprintf>). See the PPM specification (<https://netpbm.sourceforge.net/doc/ppm.html>) and the `ppm2blob.c` code for more information on the header. (Hint: the maximum pixel value is 255).
8. Write the “interleaved” pixel data (r,g,b) with `fputc` (<https://en.cppreference.com/w/c/io/fputc>). (Hint: remember to use pointers not array indexing)
9. Close the PPM file with `fclose`.
10. Free the allocated memory with `free` (<https://en.cppreference.com/w/c/memory/free>)

Use the provided `ppm2blob.c` file as a guide for each of these steps (except that file uses array indexing to access memory allocated by `malloc`); the C Programming Wikibook ([https://en.m.wikibooks.org/wiki/C\\_Programming](https://en.m.wikibooks.org/wiki/C_Programming)) is another good resource for general information writing and reading C programs.

## 5 Converting the PPM image to a PNG

Your next task is to convert the PPM image into a PNG. PNGs are quite a bit more complex and efficient. For this step you’ll use an existing tool called ImageMagick (<https://imagemagick.org>). Run the following command:

```
convert image.ppm image.png
```

The `convert` utility knows about both PPM and PNG formats. (It doesn’t know about the made-up blob format)

If your program runs correctly, you should see a beautiful PNG image that was generated by DALL-E for this assignment using the phrase, “A pretty picture for a computer systems programming assignment”.

Hint: you can download the image file you generate from the server to your local machine using `scp`. Remember to run this command from your local machine!

```
scp USERNAME@itbdcv-lnx04p.campus.pomona.edu:~/clab/image.png .
```

## 6 Feedback

Please create a file called `feedback.txt` that answers the following questions:

1. How long did each of you spend on this assignment?
2. Any comments on this assignment?

How you answer these questions **will not affect your grade**, but your assignment will not be considered complete without them.

## Submission

You should submit three files on Gradescope: `blob2ppm.c`, `image.png`, and `feedback.txt`. Before you do so, double check that both your name and your partner's name are in a comment at the top of each of your files.

Hint: you can download your solution file from the server to your local machine using `scp`. Remember to run this command from your local machine!

```
scp USERNAME@itbdcv-lnx04p.campus.pomona.edu:~/clab/blob2ppm.c .
```

Only one member should submit your solution files (but remember to tag your partner as your collaborator!), and all files should be submitted together in a single submission (hint: `command-click` is your friend).