

This first lab is UNGRADED.

As you start this lab (and any future lab), please take care to read an *entire* part before doing anything the part asks you to do. There are often important caveats or secondary instructions that we have to give *after* the initial instruction in order for them to make sense.

Getting started

The first thing you will do is to enroll in Piazza, our online Q&A platform.

Go to <https://piazza.com/cmu/spring2023/15122q/home>, create an account using your andrew email address if you don't have one already, and join the class using course key **31ebg4pzu6p**.

1.5pt

Next, you'll start getting acquainted with Linux:

If you are on a classroom computer, and generally on a Windows machine, you can access a Terminal window by opening PuTTY. You can do that by hitting the Start menu, and typing "PuTTY" in the search bar. If nothing shows up, download it from this link: <https://the.earth.li/~sgtatham/putty/latest/w64/putty.exe>. Next, follow these steps:

- (a) In the Hostname bar, enter "YOUR_ANDREW_ID@unix.qatar.cmu.edu"
- (b) keep the port number as 22.
- (c) Save these settings by entering a name (say, 'CMU') in the box right under "Saved Sessions." Afterward, hit "Save" on the right hand side.
- (d) Next, click on the "Open" button.
- (e) You will now see a new Terminal window open, and will ask you for your password.
- (f) Enter your password; you will not see any characters being entered (for security/privacy!) so don't freak out! Once you type your password, hit "Enter"

If you are on your own laptop, you need to log in to one of the andrew Linux machines. How to do so depends on what OS your laptop is running (Windows, Mac, or Linux). Go to Piazza and follow the instructions in the post "**Laptop Setup for <OS>**" where <OS> is the OS you are running on your laptop.

If you are on a cluster machine but plan to use your laptop for assignments in this course, you will want to do the laptop setup on your own later.

Once you are done, you will see a terminal window that looks something like this:

```
iliano@unix.andrew.cmu.edu's password:  
Last login: Tue Oct 17 13:30:24 2017 from takamaka.wv.cc.cmu.edu  
Welcome to the Carnegie Mellon University  
Linux timeshare pool  
  
now running Red Hat Enterprise Linux 7  
  
These machines are a shared resource. Please be considerate of other users.  
Usage guidelines and policies available at:  
http://www.cmu.edu/computing/network/guidelines/servers.html  
  
Please note: These machines reboot nightly.  
  
[iliano@unix6 ~]$
```

(The messages will look different for you.)

Navigating your account in Linux

Linux is an operating system, just like Windows or Mac OS X. In this lab, rather than using a graphical interface, you will use the terminal to enter commands directly to the OS.

- (2.a) At the prompt, **list** the files in your home directory¹ by typing

```
% ls
```

We often use the `%` or `$` character at the beginning of a line to indicate that it's something you're supposed to enter at the prompt. Don't actually type it in! Just type "`ls`" and press Enter, not "`% ls`".

- (2.b) You should see the directory **private** as one of the entries in your home directory. Move to this directory using the `cd` command, which lets you **change** the **directory** your terminal is working in.

```
% cd private
```

ACADEMIC INTEGRITY NOTE: You should store your program files and other class solutions inside the **private** directory (or a subdirectory inside this directory) since this directory is automatically set to prevent electronic access by other users. Remember that you should protect your work from being accessed by other students as part of the academic integrity policy for this course.

- (2.c) Once you `cd` into the **private** directory, **make** a new **directory** named **15122** using the `mkdir` command:

```
% mkdir 15122
```

Now go into this directory using `cd` again:

```
% cd 15122
```

Setting up your Linux Account

Now that you know how to navigate in the Linux machine, it needs to be set up so that you have syntax highlighting and can use the course tools.

- (3.a) At the prompt, enter the command

```
% wget https://web2.qatar.cmu.edu/~mhhamou/15122-s23/labs/01/15122-setup.sh
```

and execute it

```
% bash 15122-setup.sh
- files modified: ~/.bashrc, ~/emacs, ~/.vimrc (older versions are backed up)
- your default shell will now be bash
You do *not* need to run this script again
```

If you run into difficulties, ask a TA. You can alternatively look at the instructions at https://bitbucket.org/c0-lang/docs/wiki/Setting_up_your_environment (but you shouldn't need to).

¹You're probably familiar with "folders" if you've used Mac or Windows. "Directory" is the Linux name for folders.

Completing a Programming Assignment

In this section, we'll walk through the steps of downloading, completing, and submitting a programming assignment. You'll do this for each assignment, so come back here if you get confused.

- (4.a) Download the handout for this sample assignment by going to Autolab, clicking on "Sample Assignment (UNGRADED)" and then on "Download handout".

You will need to transfer the file **sample-handout.tgz** to andrew so that you can work on it on that system.

If you are on a Mac or a Linux laptop, open a new terminal and **cd** to the directory where your browser saved **sample-handout.tgz** (it's probably "Downloads"). We'll use the **scp** command to copy the file from your laptop to the Andrew servers. **scp** is for **s**ecurely **c**opying files over a network. You tell it where the file is now (the "source") and then where you want the file to go (the "destination"). Run the command

```
% scp sample-handout.tgz your_id@unix.qatar.cmu.edu:private/15122/
```

It will ask for your andrew password. Once you enter it, it will transfer the file to andrew. Go back to the terminal where you're **ssh**'d to andrew and in the **private/15122** directory. Run **ls** to see the file we just transferred:

```
% ls
sample-handout.tgz
```

If you are on a Windows laptop or a cluster computer, you would need another program to be able to upload the files that you downloaded to the andrew server. One such program is called FileZilla. You might not have to download it; hit the Start menu and type "FileZilla" and open it up. Next, follow the instructions on the link below to set it up, but in the **Host** field write **unix.qatar.cmu.edu** instead of **unix.andrew.cmu.edu**: <http://alexcappiello.com/15122-misc/winssh.shtml#filezilla>. Afterward, navigate to your lab folder you were working on (Should be private → 15122) and upload (click and drag) the file you just downloaded.

Go back to the terminal where you're **ssh**'d to andrew and in the **private/15122** directory. Run **ls** to see the file we just transferred:

```
% ls
sample-handout.tgz
```

- (4.b) **sample-handout.tgz** is a compressed archive (like a **.zip** file) consisting of several files. You can retrieve them with the following command ²:

```
% tar xfvz sample-handout.tgz
sample-handout/
sample-handout/factorial.c0
sample-handout/favorite_number.c0
sample-handout/README.txt
```

²If this command fails, try **tar xvf sample-handout.tgz**

You've now created the directory **sample-handout** containing the three files **README.txt**, **factorial.c0**, and **favorite_number.c0**. Go to this directory:

```
% cd sample-handout
```

- (4.c) Make sure you are in the **private/15122/sample-handout** directory by entering the command **pwd** to get the **present working directory** and by entering the command **ls** to see the files in that directory. You should see something like this with your **andrew id** instead of **<your_id>**:

```
% pwd
/afs/qatar.cmu.edu/<usr_number>/<your_id>/private/15122/sample-handout
% ls
factorial.c0 favorite_number.c0 README.txt
```

Editing your program

You can use any editor you wish to write and edit your programs, but we recommend you try out **vim**, or **emacs**. These editors are very powerful and can do much more than just help you edit your code (as you will see).

You can also use them from your own computer. To use **vim** or **emacs**, you will need to ssh in to one of the Linux **andrew** machines; once there, you simply run them from the terminal prompt as described below.

Another option is to use one of the more modern text editors like **VSCoDe** or **Sublime**, you will first need to install it on your computer and connect it to **unix.qatar.cmu.edu** through **SFTP** extension. If you are in doubt on how to do that, please go to one of your **CAs** during office hours and they will help you.

For this section of the lab handout, we provide instructions on **vim** and **emacs**. We highly recommend that you **try both of them**. Later, use the one you like best³.

- (4.d) Using **cd**, go into the **sample** directory. From there open the file **factorial.c0** that you downloaded from the previous part of the lab:

VIM:

```
% vim factorial.c0
```

EMACS:

```
% emacs factorial.c0
```

You should see the editor start in the Terminal, and you should see a program that looks like it computes factorial⁴. The program is written in **C0**, the language we'll be using to start the semester.

- (4.e) Edit the program **factorial.c0** and add your name and section letter at the appropriate locations. Use the instructions below for the editor you're using.

³See the course website to learn more about using these editors. They are capable of much more than what we describe here.

⁴For **Emacs** or **vim**, trying to open a file that doesn't exist (i.e., by making a typo) will create a new empty file with that name. If you see a blank file, exit the editor and try again.

VIM: This editor has two modes – *insert mode* for inserting text or code, and *command mode* for entering commands. It starts in command mode, so you can't edit immediately. Use the arrow keys to move around the file. While in command mode, pressing “i” changes the editor to insert mode, allowing you to type text. Go into insert mode and add your name and section letter. Press the Escape (ESC) key while in insert mode to return to command mode.

EMACS: You can just start typing and editing without hitting special keys. You can use the arrow keys to navigate around the file to insert code. There are many shortcuts and built-in features to Emacs but you won't need them right now. In the file, insert your name and your section letter in the appropriate comments in your program.

(4.f) Save your changes and exit the editor.

VIM: Make sure you're in command mode by pressing ESC. Then, you can save your work and exit vim by entering the sequence “:wq” followed by pressing Enter. (If you have unsaved changes you would like to discard, you'll have to enter the sequence “:q!” followed by Enter. You can also save without exiting by entering the sequence “:w” followed by Enter.)

EMACS: Once you're ready to save, press Ctrl-x (the Control key and the “x” key at the same time) followed by Ctrl-s. You can exit by pressing Ctrl-x followed by Ctrl-c. If you have not saved before exiting, Emacs will ask you whether you want to save your file (since you changed it) — press “y” for yes. (Press “n” instead if you don't want to save your changes).

(4.g) Try out your new editing skills on the file `favorite_number.c0`. You should see where the file tells you to add a line that returns your favorite number, like this:

```
int my_favorite_number() {
    /* add a line below that returns your favorite number */
    return 17; // this is *my* favorite number. Choose your own.
}
```

Running a C0 Program

You can execute a C0 program by either compiling it into executable code or loading it into an interpreter. You invoke the C0 compiler (`cc0`) and interpreter (`coin`) from the Linux command line.

The *compiler* translates your program into a lower level (machine) version of the code that can be executed by the computer. It first checks for syntax errors and will abort with an error message if it finds any.

(4.h) Be sure you're in the `sample` directory, then compile your `c0` code using the `cc0` compiler:

```
% cc0 -d factorial.c0
```

This runs the compiler with debug mode on (`-d`). During execution, the debug mode checks all the code annotations starting with `//@`. You will learn about them in class.

If there are no syntax errors, the `cc0` compiler returns to the command prompt without saying anything else. Running `ls` will show you a new file named `a.out`, which is the executable version of your program. If you have syntax errors during compilation, go back into the file with an editor and correct them.

(4.i) Run the program:

```
% ./a.out
```

The first dot says to look in the current directory and run the `a.out` executable file. This will cause the `main()` function in your program to launch, which prints the values of `0!` through `9!` in the terminal window, one per line.

Alternatively, you can use the **C0** interpreter `coin` to execute your program. An *interpreter* checks a program for syntax errors and runs it step by step. This is a good way to interact with your program in real time to test it.

(4.j) Run your program in the `coin` interpreter, starting it with `coin -d factorial.c0` and entering in the C0 statements as shown below.

```
% coin -d factorial.c0
C0 interpreter (coin)
Type '#help' for help or '#quit' to exit.
--> factorial(2);
--> factorial(3);
```

Exit the interpreter by entering `#quit` and pressing Enter, or using the keyboard shortcut Ctrl-d.

Submitting Programming Assignments

(4.k) You will submit your programming assignments using Autolab, the site where you downloaded the handout from. Let's see how that works on the files `factorial.c0` and `favorite_number.c0`. We will always submit compressed files. You do so by typing the following at the Unix prompt:

```
% tar cfzv handin.tgz factorial.c0 favorite_number.c0
```

The above command puts your files `factorial.c0` and `favorite_number.c0` into a compressed archive file named `handin.tgz`.

If you are on a Mac or a Linux laptop, open a new terminal. We'll use the `scp` command from earlier.

```
% scp your_id@unix.qatar.cmu.edu:private/15122/handin.tgz .
```

The `.` at the end means "here" - it tells `scp` to put the file in the current directory your terminal is in. If you didn't `cd` anywhere else, it's the home directory on your laptop.

If you are on a Windows laptop or a cluster computer, use FileZilla to download the file to the Windows computer. Navigate to your lab folder you were working on (Should be private → 15122 → sample-handout) and download (click and drag) the `tar` file you just created.

Next, point your browser to Autolab, go to the sample assignment's entry and upload the newly created file `handin.tgz` using the "Submit File" button. Check that you submitted the right file by clicking on the "view source" icon. Always check your submissions!

There's also an easier way to submit from an andrew computer. You can use the handin command to hand in your work. The file **README.txt** in each handout will tell you how to submit using handin. Look at the README for this sample homework to see what to do (you can view the file by opening it in an editor, like Vim or Emacs).

3pt

Written Assignments

- (5.a) You will submit your *written* assignments using Gradescope. But first we need to register at <https://gradescope.com> using **YOUR ANDREW EMAIL** and entry code **PX628B**.

Written homeworks are posted on Course Website. In a browser, go to Course Website, and click on “**Written 0 (UNGRADED)**” under “Assignments”. The folder icon in the top right corner will give you a version you can save as a PDF. Save a copy as **written-test.pdf**. You will write just your name and section number and then submit.

You can do the writing in two ways:

- (a) By entering annotations in **written-test.pdf** and then saving. The easiest way is to do so online by using **pdfescape.com** in your browser. Alternatively, several PDF viewers support annotations, including **preview** on Mac, **iAnnotate** on iOS and Android, and **Acrobat Pro** on pretty much anything — **Acrobat Pro** is installed in all non-CS cluster machines.
- (b) By printing **written-test.pdf**, writing your solution by hand, and then scanning it back to PDF. *This is pretty laborious: you will want to get the first option to work for you.*

Now that you have a “solved” version of **written-test.pdf**, go to Gradescope and upload your solution file. ***Always check your submission to be sure it looks correct!*** If you didn’t manage to find a PDF editor that works for you, simply submit the blank writeup for now.

4pt