Lab 0: Intro, Setup

Deadline: Sunday, January 21, 11:59:59 PM PT

Hello! Welcome to CS61C! We're excited to have you on board :D ~~Please pay attention as we demonstrate the safety features of this aircraft.~~ This lab may be a little long, but please read carefully; it covers many important things that will prepare you for the rest of the course!

> **Info**: You may make private questions on Ed for this assignment if you run into issues. This is an exception to the normal policy because this lab is mostly setup.
>
> We also have a list of common errors. Please check it out before posting on Ed or coming to office hours!

Exercise 1: Accessing Services

Unfortunately, assignments in this course do require some (sometimes boring) setup. Let's get that out of the way before the semester kicks in. Here's a checklist:

1. □ Ed: Make sure you're in the 61C Ed course. Ed will be our main method of communication.
2. □ Gradescope: Make sure you're in the 61C Gradescope course
3. □ PrairieLearn: Go to PrairieLearn. Click the `Add or remove courses` button, then enroll in the CS61C Spring 2024 course.
4. □ OH Queue: Go to 61C's OH (Office Hours) Queue. Make sure you can log in.
5. □ YouTube: Make sure you can view this private test YouTube video.
   - If you're not able to view it, go to https://youtube.com/channel_switcher and click on your Berkeley account's YouTube channel (you may have multiple).
6. □ Zoom: Download the Zoom app. Click the `"Sign In with SSO"` button, enter `berkeley` when prompted (the full domain should be `berkeley.zoom.us`), then follow the prompts to log in.

Accessing Gradar

> Gradar is a new service under development. Please let us know if you run into any issues by making a private question on Ed!

1. **Go** to Gradar and **log in** with your Berkeley Google account.
2. On the home screen, **confirm** that you can see the `CS 61C Spring 2024` course.

3. At the top right corner, **click** your name, then **click** `Profile`.
4. Under "GitHub: Login", **click** `Link Account` and **log in** with the GitHub account you'd like to use for 61C.

Note: Campus VPN

Unfortunately, some regions and organizations block access to our educational materials and tools. If you're unable to access any services or resources due to internet access restrictions, you can use the Berkeley campus VPN (which you will install later on in this lab).

Exercise 2: Installing Software

The following sub-sections contain instructions for specific OSes (operating systems). Please use the instructions for your specific OS; commands for the wrong OS may break things on your OS!

Ubuntu Linux

Ubuntu 18.04+ has the required programs in the default APT repositories. The following commands will install them automatically:

```
$ sudo apt update
$ sudo apt install curl git openjdk-17-jre openssh-client python3 python3-pip
```

Any terminal and any modern web browser should be sufficient for 61C.

macOS

1. □ Open the `Terminal` app.
2. □ Install the Xcode Command Line Tools:
   ```
   $ xcode-select --install
   ```
3. □ Check your Java version:
   ```
   $ java -version
   ```
4. □ If you don't already have Java 16 or higher, download and install Adoptium OpenJDK 17.
   - We recommend the `.pkg` installer.
   - If you have an Apple Silicon CPU, you want the `aarch64` version. Otherwise, you probably have an Intel/AMD CPU, so you want the `x64` version.
5. □ Check your Python version:
   ```
   $ python3 --version
   ```

6. □ If you don't already have Python 3.6 or higher, download and install Python 3.
7. □ Check that your Python install has valid SSL certificates:

```
$ python3 -c 'import urllib.request; urllib.request.urlopen("https://inst.eecs.berkeley.
```

   - If nothing is printed, your install should be OK
   - If a certificate error is thrown (e.g. `certificate verify failed: unable to get local issuer certificate`):
     1. In Finder, open your system Applications folder
     2. Open the Python install folder (e.g. `Python 3.11`)
     3. Run the `Install Certificates.command` program inside (right-click => Open)
     4. Close your existing terminal windows and open a new terminal
     5. Run the `python3` SSL check command again

Windows

1. □ Download and install Git Bash.
   - If asked by the installer, select the `"Use Windows' default console window"` option instead of `"Use MinTTY"`
2. □ Open a Git Bash terminal (Start Menu => Git Bash).
   - For 61C, please use Git Bash instead of `cmd.exe` or Powershell
3. □ Check your Java version:

```
$ java -version
```

4. □ If you don't already have Java 16 or higher, download and install Adoptium OpenJDK 17
   - We recommend the `.msi` installer.
5. □ Check your Python version:

```
$ python3 --version
```

   If it launches the Microsoft store, Python may not be installed.
6. □ If you don't already have Python 3.6 or higher, download and install Python 3

Other OSes

If you're using another Linux distribution (Alpine/Arch/Asahi/Debian/Fedora/NixOS/etc.), most of our programs should run fine when dependencies are present, but we don't have resources to test on distros other than Ubuntu. If you're having trouble, you can try reaching out on Ed or visit OH, but please note that staff has limited experience with these.

If you use *BSD, HaikuOS, TempleOS, ToaruOS, or anything else, we unfortunately don't have the resources to support these platforms. If programs don't work, you can use the instructional computers (or other supported platforms).

Exercise 3: Instructional Accounts and Servers (hive machines!)

The hive machines are instructional servers that you will use for coursework. You can connect to these machines using SSH (Secure SHell Protocol). Let's set that up!

You can use Hivemind to check if each hive machine is busy or offline. Note that Hivemind shows machines that don't start with `hive`; those won't work with 61C. Hivemind is currently not showing the correct information due to some updates to the instructional machines, but hopefully it will be fixed in the upcoming days.

> **Warning**: The CalVisitor WiFi network on campus blocks SSH. Make sure you're not on CalVisitor when working on 61C things.

Campus VPN Setup

Follow the instructions here to install and set up the bSecure Remote Access VPN. Make sure there are no errors during your installation process. We will refer to this VPN as "the campus VPN" from now onwards.

Please stay connected to the Campus VPN for the remainder of this lab.

This is our first semester using this, so if you run into any issues, please make a follow-up in the Lab 0 Ed post or make a private question on Ed.

Instructional Account Setup

1. □ Sign up for a `cs61c` instructional account on WebAccount.
   - You'll need your password for the rest of this exercise.
   - It may take a day or two after you're enrolled/waitlisted before you're able to create an account.
   - If you're a pending concurrent enrollment student, or filled out the "Plan to Enroll Later" form, we're requesting accounts for you and you should be able to create an account within 5 days of submitting your application or the form.

2. □ Try connecting to a hive machine via SSH (make sure you are connected to the campus VPN):

   ```
   $ ssh cs61c-???@hive2.cs.berkeley.edu
   ```

   Remember to replace `cs61c-???` with your instructional account username. When typing your password, nothing will appear; this is normal for many terminal programs.

   - If you get `Permission denied, please try again`, check that you're typing the correct username/password. If you're copy-pasting the password, try typing it out manually.
   - If you're getting "`Connection timeout`" or other connection errors, make sure you're not on CalVisitor or another network that blocks SSH, and make sure you're connected to the campus VPN.
   - If you're getting "`Connection refused`" or "`Connection timeout`" or other connection errors, the machine might be temporarily down or refusing connections. Check Hivemind and try another hive machine to use (e.g. replace `hive2` with `hive3`).

3. □ After a successful connection, you might be prompted to enter some info, including your name and email. If you're not, skip to the next step.
   - Please enter your Berkeley email.
   - Please double check the spelling of your email, SID, and name.

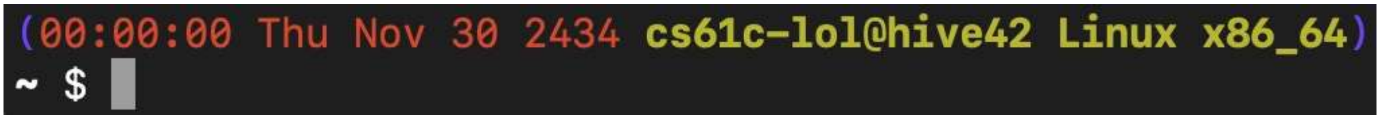
4. □ After entering your info, make sure your info is correct by running:

   ```
   $ check-register
   ```

   If something is incorrect, run:

   ```
   $ re-register
   ```

5. □ After a successful connection, check that you have a red-yellow prompt similar to:

   ```
   (00:00:00 Thu Nov 30 2434 cs61c-lol@hive42 Linux x86_64)
   ~ $ 
   ```

   If your prompt is white, run:

   ```
   $ /home/ff/cs61c/bin/fix-dotfiles && exit
   ```

   Then, start from step 2 again.

6. □ Run `exit` to exit the SSH session.

Connecting to Hive Machines With a Shortcut

We can configure a SSH host alias, which will let us use `ssh hive#` instead of `ssh cs61c-???@hive#.cs.berkeley.edu`.

This section will also introduce you to Vim, a terminal-based text editor.

1. □ Open a new terminal window.
2. □ Create a `~/.ssh` folder:

```
$ mkdir -p ~/.ssh
```

3. □ Open `~/.ssh/config` in Vim:

   ```
   $ vim ~/.ssh/config
   ```

4. □ Press `i` to enter insert mode. `-- INSERT --` should appear at the bottom left.
5. □ If you see the following two lines together, they are from 61B. If you don't need them anymore, use the arrow keys and backspace to delete them.

   ```
   Host *.cs.berkeley.edu *.eecs.berkeley.edu
   IdentityFile ~/.ssh/cs61b_id_rsa
   ```

   If you still need to use your 61B setup, reach out to 61C course staff.

6. □ Copy the following text into the file:

   ```
   # Begin CS61C hive machine config v2.0.0
   Host hive? hive??
       HostName %h.cs.berkeley.edu
       ProxyJump %r@instgw.eecs.berkeley.edu
   Match Host *.cs.berkeley.edu,*.eecs.berkeley.edu
       Port 22
       User cs61c-???
       ServerAliveInterval 60
   # End CS61C hive machine config v2.0.0
   ```

   Remember to replace `cs61c-???` with your instructional account username. Leave the question marks in `Host hive? hive??` as-is.

7. □ Exit insert mode by pressing `Esc`. `-- INSERT --` should be gone.
8. □ Save the file by typing `:w`, then `Enter`.
9. □ Quit Vim by typing `:q`, then `Enter`.
10. □ Try SSH-ing to a hive machine now:

    ```
    $ ssh -o "ProxyJump=none" hive7
    ```

    You should see that red-yellow prompt after entering your password. The `-o "ProxyJump=none"` flag is only required until you complete the next section.

11. □ Run `exit` to exit the SSH session.

In the future (after you complete this exercise), you can run `ssh hive#` to connect to a hive machine. There are 30 hive machines, `hive1` through `hive30`; it doesn't matter which one you use since all of them share the same files.

Connecting to Hive Machines Without a Password

1. □ Open a new terminal window.

2. ☐ Run the following command, it will print out any SSH keys you have and generate a new one if none exists:

   ```
   $ curl -sS https://raw.githubusercontent.com/61c-teach/sp24-lab-starter/main/lab00/get-s
   ```

   Make note of the location of your SSH key, it will be used later in the lab.
3. ☐ Copy your public key to your instructional account:

   ```
   $ ssh-copy-id -o "ProxyJump=none" hive3
   ```
4. ☐ Try SSH-ing to a hive machine now:

   ```
   $ ssh hive5
   ```

   You should see that red-yellow prompt without being prompted for your instructional account password.
5. ☐ Run `exit` to exit the SSH session.

If you're getting tired of reading, try taking a short break; anyone want a game of snake?

Exercise 4: GitHub Setup

Configuring Your Local Machine

Let's configure your local user account to authenticate to GitHub using your SSH key.

1. ☐ Open a new terminal window.
2. ☐ Print your public key (make sure to replace `path_to_ssh_key` with the location printed out above and add the `.pub` suffix):

   ```
   $ cat path_to_ssh_key.pub
   ```

   It should look similar to the following (length may differ):

   ```
   ssh-ed25519 AAAAC3NzaC1lZDI1N6jpH3Bnbebi7Xz7wMr20LxZCKi3U8UQTE5AAAAIBTc2HwlbOi8T some_co
   ```
3. ☐ In your browser, go to GitHub => Settings => SSH and GPG Keys => New SSH key and add your public key.
   - Set the title to something that helps you remember what device the key is on (e.g. `CS61C Laptop`).
4. ☐ Try connecting to GitHub with SSH:

   ```
   $ ssh -T git@github.com
   ```

   If all went well, you should see something like:

   ```
   Hi USERNAME! You've successfully authenticated, but GitHub does not provide shell access
   ```

In the future, when cloning repos that require authentication (e.g. the private labs repo you'll create next), instead of using the HTTPS repo URL (like `https://github.com/USERNAME/REPO_NAME.git`), you should use the SSH repo URL instead (like `git@github.com:USERNAME/REPO_NAME.git`). For example, in `https://github.com/61c-student/sp24-lab-ghost.git`, the repo named `sp24-lab-ghost` is under the `61c-student` user/organization, so the SSH clone URL would be `git@github.com:61c-student/sp24-lab-ghost.git`.

Configuring Your Instructional Account

Let's configure your instructional account to authenticate to GitHub using your SSH key.

1. □ Open a new terminal window.
2. □ SSH to a hive machine:

   ```
   $ ssh hive11
   ```

   Again, you should see that red-yellow prompt.
3. □ Run the following command, it will print out any SSH keys you have and generate a new one if none exists:

   ```
   $ curl -sS https://raw.githubusercontent.com/61c-teach/sp24-lab-starter/main/lab00/get-s
   ```

   Make note of the location of your SSH key, it will be used later in the lab.
4. □ Print your public key (make sure to replace `path_to_ssh_key` with the location printed out above and add the `.pub` suffix):

   ```
   $ cat path_to_ssh_key.pub
   ```

   It should look similar to the following (length may differ):

   ```
   ssh-ed25519 AAAAC3NzaC1lZDI1N6jpH3Bnbebi7Xz7wMr20LxZCKi3U8UQTE5AAAAIBTc2HwlbOi8T your_em
   ```
5. □ In your browser, go to [GitHub => Settings => SSH and GPG Keys => New SSH key]() and add your public key.
   - Set the title to something that helps you remember that this key is on your instructional account (e.g. `CS61C Hive`).
6. □ Try connecting to GitHub with SSH:

   ```
   $ ssh -T git@github.com
   ```

   If all went well, you should see something like:

   ```
   Hi USERNAME! You've successfully authenticated, but GitHub does not provide shell access
   ```
7. □ Run `exit` to exit the SSH session.

Exercise 5: Fun with Git

In this exercise, you'll get your Git repository ("repo") for labs and work with a variety of Git commands.

The instructions for this exercise assume you're using Vim to edit text files. For a quick start guide on vim, check out the Vim Basics section of the Appendix.

If you want to use another text editor, go ahead. However, staff will not be able to provide support for editors other than vim. Some examples:

- Nano: simple and beginner-friendly compared to Vim. It provides a helpful list of commands at the bottom of the interface (the `^` means the `Ctrl` key). Ships with many UNIX distributions (e.g. macOS, Ubuntu Linux). Open with `nano file.txt`.
- Visual Studio Code (VSCode): fancy graphical text editor. It has some pretty helpful extensions, including a Remote SSH extension that allows you to edit files over SSH in VSCode itself instead of a terminal-based editor. However, some students have ran into complicated setup issues in the past.

Before you come to lab 1, make sure that you are comfortable with either editing your files on the hive by using your text editor of choice.

Getting Your Lab Repo

Visit `Gradar`, start the assignment named `Labs`, and create a repo. This will be your personal repo for any lab work you do throughout the semester.

Configuring Git

Before we start, let's tell Git who you are. This information will be used to sign and log your commits. You may not need to do this on your local machine if you've set up Git before, but you'll need to do this on your instructional account.

On your local machine, tell Git your name and email:

```
$ git config --global user.name "John Doe"
$ git config --global user.email johndoe@example.com
```

SSH to a hive machine, and run the same commands on your instructional account.

Cloning Your Repo

Git has the concept of "local" and "remote" repositories. A local repo is located wherever your terminal session is; if you're in a SSH session, the local repo is a folder on a hive machine; if your terminal session is on your local machine, the local repo is located on your local machine's filesystem. A remote repo (e.g. GitHub repo) is typically hosted on the Internet.

You have a lab repository on GitHub, but not locally (it would be a little worrying if a website could automatically access your local files). To get a local copy of this repository, you can use `git clone`, which will create a local repository based on information from a remote repo.

SSH into a hive machine. On the hive machine, clone the repository into a folder named `labs`:

```
$ git clone git@github.com:61c-student/sp24-lab-USERNAME.git labs
```

Remember to replace `sp24-lab-USERNAME` with your actual repo name!

Exploring Your Repo: Git

`cd` into this new folder. List all hidden files (`ls -a`). Do you see a hidden file/folder?

There is indeed a folder named `.git`. Its presence indicates that the current folder (folder containing `.git`) holds a Git repository.

Take a look at your repo's current remotes and status:

```
$ git remote -v
$ git status
```

`git clone` has already worked a bit of magic here -- there's a remote called `origin`, and its URL points to your labs repo on GitHub! You're on a local branch called `main`, which is "tracking" `origin/main` (the `main` branch on the `origin` remote).

> **Note**: GitHub now uses `main` as the default branch name, not `master`

Throughout the semester, course staff may make updates to starter code to fix bugs or release new labs. To receive these updates, you'll need to add another remote.

```
$ git remote add starter https://github.com/61c-teach/sp24-lab-starter.git
```

> **Note**: Our starter repos are public, and you don't have write access to them, so you should actually use the unauthenticated HTTPS clone URL in this case!

If you ever want to pull **updated** starter code, you'd execute the following command:

```
$ git pull starter main
```

Try it out now! Since you just started lab, there might not be any updates to pull yet.

Exploring Your Repo: Files

Your labs repo structure looks like:

```
labs/ (current directory)
    lab00/
        code.py
        gen-debug.sh
        get-ssh-key.sh
        init.sh
    tools/
        download_tools.sh
    README.md
```

Starting from the `labs` repo, run `ls`. The output should look like:

```
~/labs $ ls
lab00  README.md  tools
```

Now, `cd` into the `lab00` folder, then list its files. The output should now look like:

```
~/labs/lab00 $ ls
code.py  gen-debug.sh  get-ssh-key.sh  init.sh
```

In paths, `.` by itself refers to the current directory. The following commands will list the files present in the `lab00` folder:

```
~/labs/lab00 $ ls
~/labs/lab00 $ ls .
~/labs/lab00 $ ls ./././.
```

How do you get back to the overall labs folder? In paths, `..` by itself refers to the parent folder.

```
~/labs/lab00 $ ls ..
lab00   tools
~/labs/lab00 $ ls ../..
<whatever's in your home folder, probably many files>
~/labs/lab00 $ cd ..
~/labs $ ls
```

```
lab00   tools
```

The following sequences of commands will all list the files in `lab00`:

```
~/labs $ cd lab00
~/labs/lab00 $ ls
```

```
~/labs $ ls lab00
```

```
~/labs $ cd tools
~/labs/tools $ ls ../lab00
```

```
~/labs $ cd lab00
~/labs/lab00 $ ls ../lab00/../lab00/../lab00
```

Try experimenting a bit!

Fizzing and Buzzing

If you started working on other labs, make sure to copy your work somewhere else before starting this exercise, since your work may be overwritten in this exercise.

1. `cd` into the `lab00` folder in your repo, and take a look at the files present (`ls`). Then, run the following command to initialize the lab:

   ```
   $ bash init.sh
   ```

   Make sure that no errors are printed.

2. Use Vim to open up `code.py` and look through the `fizzbuzz(num)` function. It should:

   - Print `"num: fizz"` if num is a multiple of 3
   - Print `"num: buzz"` if num is a multiple of 5
   - Print nothing if the num is not a multiple of 3 or 5

   However, if you run the program (`python3 code.py`), that doesn't seem to happen! Try to fix this bug by only editing the `if` and `elif` statements. After fixing the code, save, add, and commit your work using `git add` and `git commit`.

   In many environments, `git commit` will open up Vim for editing the commit message. If you're confused on how to use it, check out the Vim Basics section of the Appendix.

3. After committing your fix, push your work.

   Or at least, try to push your work. You should encounter an error:

   ```
    ! [rejected]        main -> main (non-fast-forward)
   error: failed to push some refs to 'github.com:61c-student/sp24-lab-username.git'
   hint: Updates were rejected because the tip of your current branch is behind
   ```

```
hint: its remote counterpart. Integrate the remote changes (e.g.
hint: 'git pull ...') before pushing again.
hint: See the 'Note about fast-forwards' in 'git push --help' for details.
```

If you didn't encounter an error, try starting from step 1 again, or contact course staff if it keeps happening.

Throughout the semester, you'll probably run into many strange errors. It helps to break them down into smaller chunks, and see if you can find out what each chunk is saying. As an example, let's break that down:

- `"failed to push some refs to REPO_URL"`: the push failed
- `"the tip of your current branch is behind its remote counterpart"`: the remote repo (on GitHub) has commits that your local repo doesn't
- `"Integrate the remote changes (e.g. 'git pull ...') before pushing again"`: we need to tell Git how to integrate the mysterious commits

Try pulling the remote changes with `git pull`.

- If you get a `"fatal: Need to specify how to reconcile divergent branches."`, run `git config --global pull.rebase false`, then try pulling again
- If you get a `"fatal: Not possible to fast-forward, aborting"`, try `git pull --ff`
- If you get a `"fatal: Need to specify how to reconcile diverent branches"`, try `git pull --ff`

If everything went well, you should encounter another error:

```
Auto-merging lab00/code.py
CONFLICT (content): Merge conflict in lab00/code.py
Automatic merge failed; fix conflicts and then commit the result.
```

Uh oh, a merge conflict:

- `"Merge conflict in lab00/code.py"`: both the remote repo and local repo have commits that made changes to `lab00/code.py`
- `"Automatic merge failed"`: Git tried to figure out how to integrate the commits, but couldn't
- `"fix conflicts and then commit the result"`: Looks like we need to manually resolve the merge conflict!

You can check `git status`:

```
On branch main
Your branch and 'origin/main' have diverged,
and have 1 and 1 different commits each, respectively.
  (use "git pull" to merge the remote branch into yours)

You have unmerged paths.
  (fix conflicts and run "git commit")
  (use "git merge --abort" to abort the merge)
```

```
Unmerged paths:
  (use "git add <file>..." to mark resolution)
  both modified:   code.py
```

Open the conflicted file in Vim. You should see something like:

```
def fizzbuzz(num):
<<< HEAD
  "your code"
===
  "not your code"
>>> remote-commit-hash

for i in range(0, 20):
```

It looks like your imaginary partner, Oski, also tried to fix the bug, without telling you. *Dangit Oski*! Oski's code seems rather... inefficient, so you want to keep your fix. However, Oski did do something useful: there's another `if` case, so multiples of 15 will print 1 line with "fizzbuzz" rather than 2 lines with "fizz" and "buzz". In other words, Oski and you have both made changes you would like to keep!

Now, with that in mind, fix the `fizzbuzz(num)` function by integrating both versions into one, and then removing extra merge conflict markers (`<<< HEAD`, `===`, `>>> commit-hash`). The fixed function should look something like the following pseudocode:

```
def fizzbuzz(num):
  if multiple of 15:
    # print num: fizzbuzz
  elif multiple of 3:
    # print num: fizz
  elif multiple of 5:
    # print num: buzz
```

When you're done, save, add, and commit your work. Now, if you push, there shouldn't be a conflict anymore. One merge conflict defeated!

4. On your local machine (NOT on your instructional account over SSH), clone your labs repo (remember to clone via SSH as demonstrated above, not HTTPS), and `cd` into the `lab00` folder. Then, run the following command:

   ```
   $ bash gen-debug.sh
   ```

   This creates a file named `debug.txt` that records a bit of debugging information for the autograder. Add, commit, and push this file.

5. Still on your local machine, `cd` into the `tools` folder in your labs repo. Then, run the following command:

   ```
   $ bash download_tools.sh
   ```

If you see warnings about `Illegal date format for -z` or `Disabling time condition`, that is expected behavior.

This downloads Logisim and Venus, which we'll need later. Check that Logisim runs:

```
$ java -jar logisim-evolution.jar
```

If a window pops up, it works! Feel free to close it; you won't need it for a while.

Submission

You made it! That was quite a bit of reading and head-scratching, but you're now somewhat more familiar with the tools you'll be using for the rest of the semester. Worth it!

Every lab will have autograded exercise(s). To submit to the autograder, you'll need to push your work to your lab repository on GitHub. Then go to the corresponding assignment on Gradescope (`Lab 0` for this lab), select your lab repository, and submit. After a short wait, the page should show your autograder score for the lab.

Remember, to get credit for a lab, make sure you have finished all the exercises and passed all the autograder tests by the deadline!

Appendix

These are some tools you may find helpful, but are by no means required for this course :)

Vim Basics

`vim` is a text editor included on the hive machines and many UNIX-based distributions.

Note: We'll be using Vim in most of our examples and documentation, but we have no hard requirement on which text editor you use; you're welcome to pick whatever you're comfortable with, but you should know how to use at least one terminal-based text editor.

To open a file from your current directory, pass the file name to Vim:

```
$ vim filename
```

To open a file from another directory, use a relative or absolute path:

```
$ vim ../other-folder/filename
```

Some useful Vim commands:

Command	**Explanation**
Esc `:q`	Closes (quits) Vim without saving
Esc `:wq`	Closes Vim after saving
Esc `:w`	Saves your file
Esc `:q!`	Force-quit Vim (for when you've made changes but do not wish to save them)
Esc `i`	Insert mode, allows you to type into the file
Esc `/cats`	Searches your file for the nearest occurrence of the string "cats". Press `n` to go to the next occurrence or `N` to go to the previous
Esc `:set nu`	Shows line numbers within your file
Esc `:tabe <filepath>`	Opens the file at `filepath` in a new tab. You can use Tab for autocompletion
Esc `:tabn`	Go to the next tab in the tab bar
Esc `:tabp`	Go to the previous tab in the tab bar

Note: these commands are preceded by Esc because you'll need to press the escape key on your keyboard to switch you out of your current mode. For example, if I'm inserting (typing) into a file and want to save, I'd have to hit Esc to get out of insert mode, then type `:w` to save my file. If you aren't in a mode (i.e. you've just opened your file) you don't need to hit escape first, but it won't hurt :)

By default, Vim doesn't enable mouse support or line numbers. If you want these:

1. Open up `~/.vimrc` (`vim ~/.vimrc`)
2. To enable your mouse, add a new line containing `set mouse=a`
3. To enable line numbers, add a new line containing `set number`
4. Save and quit. Try opening your vimrc file again

Vim has many more configuration options available -- feel free to experiment with Vim resources you find online!

We also have a Vim for CS61C guide that you can reference. Thanks Yijie!

Command Line Essentials

If you took CS61A and CS61B, you likely have some experience with a command line interface (CLI) and terminal commands. We'll be using the CLI a lot in this course, so let's take a moment to review some of the basics.

Example commands will be formatted like:

```
$ echo Hello world
```

In this case, `echo` is the command, and `Hello` and `world` are arguments. Typing that line in your terminal will run the command. In this case, it just prints `Hello world` to your terminal.

Flags are commonly used to specify program options or alter behavior. They usually begin with one or two dashes, and can optionally take an argument.

```
$ git --version | cat
$ python3 -c 'print("Hello world")'
```

It's generally recommended to wrap strings that should be a single argument in single quotation marks (e.g. `'longer string with *&)_@#(&$! symbols'`), or you may run into unintended behavior -- many of those symbols actually do something if left unquoted/unescaped!

You may find it helpful to review 61B's list of common CLI commands.

CLI Keyboard Shortcuts

When typing commands or file paths:

- `Tab` will try autocomplete the current term based on what you wrote so far
  - If the current directory has `filename1.txt` and `filename2.txt`, `f` `Tab` `1` `Tab` will result in `filename` after the first tab, and `filename1.txt` after you type `1` and the second tab
- `Up Arrow` and `Down Arrow` will allow you to move through commands you've used previously, so you don't need to type them again.
- `Ctrl` + `a` will move the cursor to the beginning of the current line (helpful for fixing mistakes)
- `Ctrl` + `e` will move the cursor to the end of the current line (also helpful for fixing mistakes)
- `Ctrl` + `r` will let you search through your recently used commands

Hello World

`echo` repeats whatever arguments you give it:

```
$ echo Hello World
```

If your string has special characters, surrounding it in single/double-quotes avoids triggering unintended shell features:

```
$ echo "It's morbin time!"
```

Working With Files

`touch` will create a blank file with the file name you provided.

```
$ touch example.txt
```

This will create a file named `example.txt` with nothing inside.

If you'd like to create a file and add text in one go, you can use:

```
$ echo 'Your contents here' > example.txt
```

This will create a file with the name `example.txt` in your current directory. If the file already exists, it will be overwritten. The file will contain `Your contents here`, without the quotation marks. The `>` symbol takes one argument which redirects where data printed to stdout is sent. Here, we are redirecting the output of `echo` to a file named `example.txt`.

You can view the contents of a file with the `cat` or `less` commands.

```
$ cat example.txt
$ less example.txt
```

`cat` print the contents of `example.txt` to your terminal. `less` opens a basic viewer which allows you to scroll and search.

`scp` - "Secure Copy"

The `scp` program is used for copying files between computers using the SSH protocol.

Sometimes, you may want to get individual files or entire folders from the hive machines onto your local system, or vice versa. You can do this by using `scp`:

```
$ scp <source> <destination>
```

To specify a remote source or destination, use `username@host:path`. To specify a local destination, just use `path`. As an example:

```
$ scp hive1:~/some-folder/example.txt ~/Downloads/
```

Assuming my username is `cs61c-???`, the above command would connect to `hive3` and copy `~/some-folder/example.txt` on my instructional account to `~/Downloads/example.txt` on my local machine.

If I wanted to copy the other direction (from my local machine to a hive machine) I would use:

```
$ scp ~/Downloads/example.txt hive1:~/some-folder/
```

`scp` by default only works with files. To copy folders, you need to tell scp to "recursively" copy the folder and all its contents, which you can do with the `-r` flag:

```
$ scp -r hive1:~/some-folder ~/Downloads/
```

Pay attention to the slashes: writing `some-folder` will copy the folder itself and files inside, while `some-folder/` will only copy the files inside.

> **Warning**: Running `scp` on the hive machines (e.g. when you're in a SSH session) is usually not desired behavior. Running `scp example.txt hive4:~/example.txt` on a hive machine will copy `example.txt` to... the same place. You probably want to run it in a local terminal session!