Lab Tasks

In this lab you'll set your computer up for remote access to the CSE lab computers and practice with commands that work with the filesystem.

Part 1 – Meet Your Group!

We've organized everyone into groups of 6 students for discussion. These groups will be somewhat stable throughout the quarter, though some small changes might happen. You will have a tutor or TA assigned to your group for help and discussion.

Your discussion leader will share a Google Doc with your group where you can fill in notes as you work; this document is only for your group. Your discussion leader will *not* take notes for you, you can have someone volunteer to take notes or come up with a way to share the role.

Write down in notes In your groups, share, and note in the running notes document (discussion leaders, you answer these as well!):

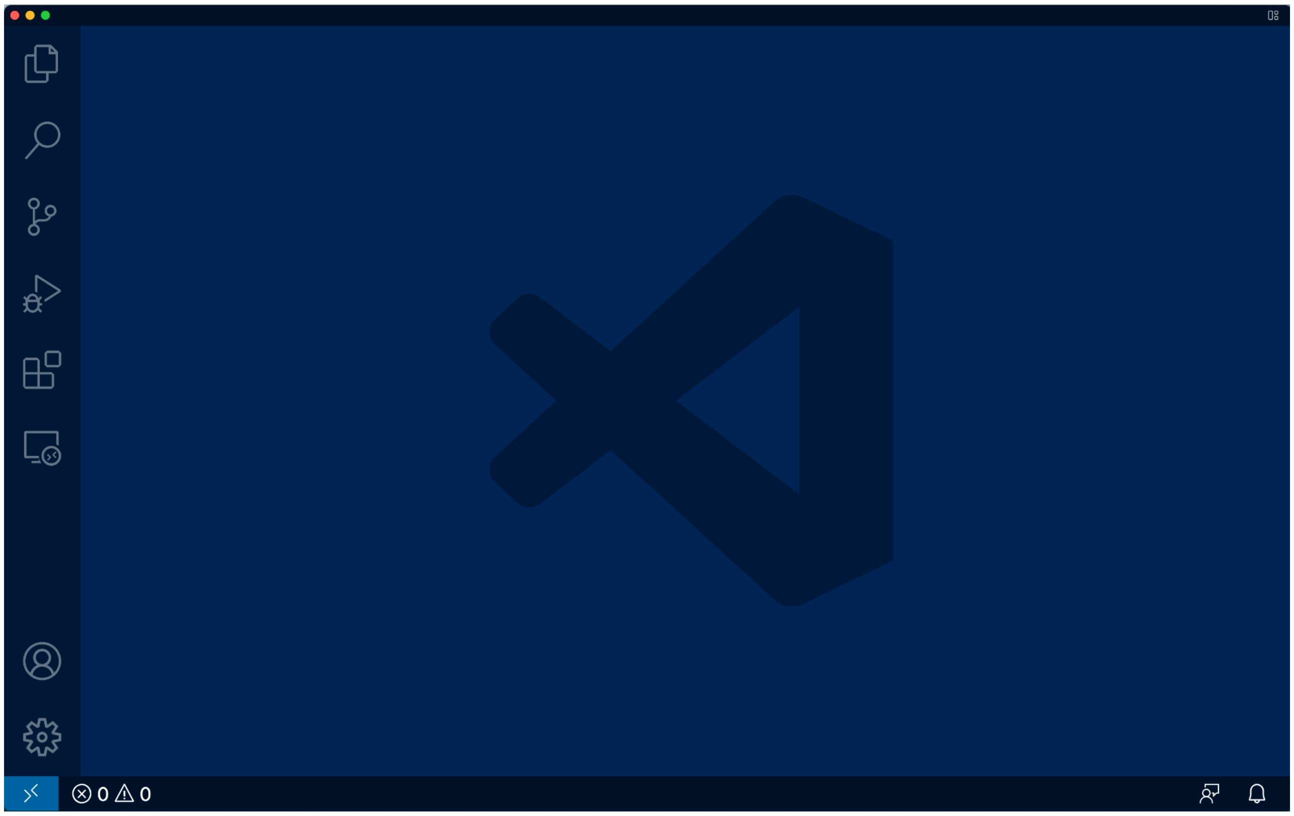
- How you'd like people to refer to you (pronounce your name/nickname, pronouns like he/her/they, etc)
- Your major
- What UCSD college you're in

Part 2 – Visual Studio Code

In Your Group for 10 minutes

Go to the Visual Studio Code website **https://code.visualstudio.com/**, and follow the instructions to download and install it on your computer. There are versions for all the major operating systems, like OSX (for Macs) and Windows (for PCs). If you run into an error installing Visual Studio Code, speak up! You can ask for help, and the tutor or someone in your group might be able to answer for you!

When it is installed, you should be able to open a window that looks like this (it might have different colors, or a different menu bar, depending on your system and settings):



Write down in notes: Everyone should share a screenshot of VScode open – help folks figure it out if it won't install. If someone gets stuck, take a screenshot of the error message or point at which they are stuck so we can help them figure it out later, and they can decide to keep trying (potentially with the tutor helping) or move on.

Part 3 – Remotely Connecting

In Your Group for 15 minutes

Many courses in CSE use course-specific accounts. These are similar to accounts you might get on other systems at other institutions (or a future job). We'll see how to use your machine to connect to a remote computer over the Internet to do work there.

There is a first step you need if you're on Windows: install a program called OpenSSH, which is a program that can connect your computer to other computers that have this kind of account:

Install OpenSSH

Then, look up your course-specific account for CSE15L here:

https://sdacs.ucsd.edu/~icc/index.php

Then, in Visual Studio Code, we are going to connect to the remote computer using VSCode's remote option. For reference, we're following the steps in the **"Connect to a remote host"** step.

For the first step, open a terminal in VSCode (Ctrl + `, or use the Terminal → New Terminal menu option). Your command will look like this, but with the `zz` replaced by the letters in your course-specific account.

```
$ ssh cs15lsp22zz@ieng6.ucsd.edu
```

(That's one, five, l (not one); the one and l look very close in some fonts.)

Since this is likely the first time you've connected to this server, you will probably get a message like this:

```
⤇ ssh cs15lsp22zz@ieng6.ucsd.edu

The authenticity of host 'ieng6.ucsd.edu (128.54.70.227)' can't
be established.
```

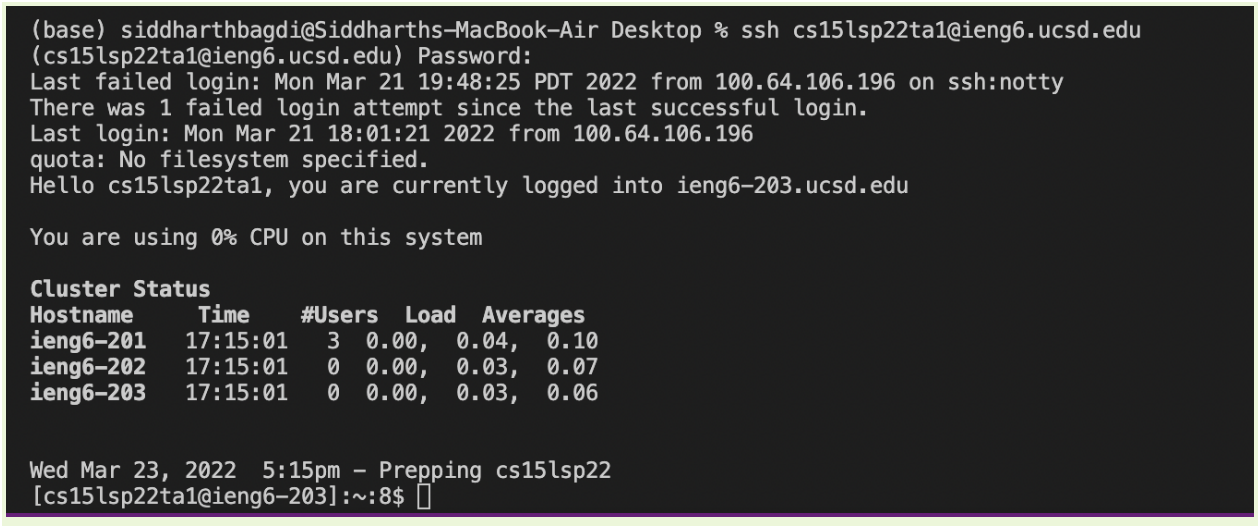
```
RSA key fingerprint is
SHA256:ksruYwhnYH+sySHnHAtLUHngrPEyZTDl/1x99wUQcec.

Are you sure you want to continue connecting
(yes/no/[fingerprint])?
```

Say yes to these messages when you are connecting to a new server for the first time; it's expected to get this message in that case. If you get this message when you're connecting to a server you connect too often, it could mean someone is trying to listen in on or control the connection. This answer is a decent description of what's going on: **Ben Voigt's answer**

So type `yes` and press enter, then give your password; the whole interaction should look something like this once you give your password and are logged in:

```
⤇ ssh cs15lsp22zz@ieng6.ucsd.edu

The authenticity of host 'ieng6-202.ucsd.edu (128.54.70.227)'
can't be established.

RSA key fingerprint is
SHA256:ksruYwhnYH+sySHnHAtLUHngrPEyZTDl/1x99wUQcec.

Are you sure you want to continue connecting
(yes/no/[fingerprint])?

Password:

Last login: Sun Jan  2 14:03:05 2022 from
107-217-10-235.lightspeed.sndgca.sbcglobal.net

quota: No filesystem specified.

Hello cs15lsp22zz, you are currently logged into
ieng6-203.ucsd.edu



You are using 0% CPU on this system
```

```
Cluster Status

Hostname      Time    #Users  Load  Averages

ieng6-201   23:25:01   0  0.08,  0.17,  0.11

ieng6-202   23:25:01   1  0.09,  0.15,  0.11

ieng6-203   23:25:01   1  0.08,  0.15,  0.11


Sun Jan 02, 2022 11:28pm - Prepping cs15lsp22
```



```
(base) siddharthbagdi@Siddharths-MacBook-Air Desktop % ssh cs15lsp22ta1@ieng6.ucsd.edu
(cs15lsp22ta1@ieng6.ucsd.edu) Password:
Last failed login: Mon Mar 21 19:48:25 PDT 2022 from 100.64.106.196 on ssh:notty
There was 1 failed login attempt since the last successful login.
Last login: Mon Mar 21 18:01:21 2022 from 100.64.106.196
quota: No filesystem specified.
Hello cs15lsp22ta1, you are currently logged into ieng6-203.ucsd.edu

You are using 0% CPU on this system

Cluster Status
Hostname     Time    #Users  Load  Averages
ieng6-201   17:15:01   3  0.00,  0.04,  0.10
ieng6-202   17:15:01   0  0.00,  0.03,  0.07
ieng6-203   17:15:01   0  0.00,  0.03,  0.06


Wed Mar 23, 2022  5:15pm - Prepping cs15lsp22
[cs15lsp22ta1@ieng6-203]:~:8$ 
```

Now your terminal is connected to a computer in the CSE basement, and any commands you run will run on that computer! We call your computer the *client* and the computer in the basement the *server* based on how you are connected.

If, in this process, you run into errors and can't figure out how to proceed, ask! When you ask, take a screenshot of your problem and add it to your group's running notes document, then describe what the fix was. If you don't know how to take a screenshot, ask!

Remember – it is **rare** for a tutorial to work perfectly. We often have to stop, think, guess, Google search, ask someone, etc. in order to get things to work the way the tutorial says. I look up the right way to describe the `(yes/no)` answer on the first login all the time, for example. So you are helping your group *learn about potential issues* when you do this, and that's a **major learning outcome of the course!** If you see someone else have an issue that you didn't, ask why, and what might be different about what you did, or how your environment is set up. You will learn by reflecting on this.

Write down in notes When you're done, **discuss** what you saw upon login. Take a screenshot or copy/paste the output. Did you all see the same thing? What might the differences mean? Note the results of your discussion in the notes document.

Part 4 – Run Some Commands

Try running the commands `cd`, `ls`, `pwd`, `mkdir`, and `cp` a few times in different ways, both on *your* computer, and on the remote computer after ssh-ing. Discuss in your group what you see. Can you cause them to produce error messages? What do they mean? If you're on Windows, what happens when you use them on Windows?

Here are some specific useful commands to try:

- `cd ~`
- `cd`
- `ls -lat`
- `ls -a`
- `ls <directory>` where `<directory>` is `/home/linux/ieng6/cs15lsp22/cs15lsp22abc`, where the `abc` is one of the other group members' username
- `cp /home/linux/ieng6/cs15lsp22/public/hello.txt ~/`
- `cat /home/linux/ieng6/cs15lsp22/public/hello.txt`

Write down in notes: Copy at least one example from each group member, with an explanation, into your shared notes doc.

Group leader note: As a tip when leading the group, I think it’s a good idea to show ls -l, ls -a, ls -t, and then have them realize -lat is just a combination of the 3 commands

Hint: To log out of the remote server in your terminal, you can use:

- Ctrl-D
- Run the command `exit`

You can also open more terminals in VSCode (there is a little + button at the top of the terminal window where you can create another).

Part 5 – Moving Files over SSH with scp

So far we’ve seen how we can do some work on local and remote computers. One key step in *working remotely* is being able to copy files back and forth between the computers. There are lots of options for how to do this – you might have done it yourself in the past by sending yourself an email, or storing it in Google Drive or Dropbox and accessing it from another computer later.

We’ll now see another way to copy a file (or many files!) from your computer to a remote computer. The command is called `scp`, and we will always run it from the *client* (that means from your computer, not logged into `ieng6`). Create a file on your computer called `WhereAmI.java` and put the following contents into it:

```
class WhereAmI {

  public static void main(String[] args) {

    System.out.println(System.getProperty("os.name"));
    System.out.println(System.getProperty("user.name"));

    System.out.println(System.getProperty("user.home"));

    System.out.println(System.getProperty("user.dir"));

  }

}
```

Run it using `javac` and `java` on your computer. What do you see? (If you don’t have `java` installed on your computer, skip this step).

Then, in the terminal from the directory where you made this file, run this command (as usually, using your username):

```
scp WhereAmI.java cs15lsp22zz@ieng6.ucsd.edu:~/
```

You should be prompted for a password just like when you log in with `ssh`. If you get errors, ask your group members for help! You’ll all learn.

Then, log into ieng6 with ssh again, and use `ls`. You should see the file there in your home directory! Now you can run it *on the ieng6 computer* using `javac` and `java`. Since `java` is installed on the *server*, everyone should be able to run it no matter the client.

Write answer in notes: Try to get a screenshot of everyone successfully *using `scp` and `ssh`. If someone can’t, no worries! Get a screenshot of where *they got stuck (don’t try to resolve an error for more than a few minutes) and *put that in the notes so we can help with it later.

Write answer in notes: What's different about the output when you run this on the client vs. the server? What does this mean for what `getProperty` does?

What we see here is one solution for running code remotely – we can copy files to a remote server with `scp`, then log in and run them there.

Before you go on, do the following:

- Have someone on your team start a timer
- Make a change to WhereAmI.java and save the file
- Copy the file to the remote server
- Log into the remote server and run the file
- Stop the timer

Write answer in notes: How long did it take you? (Not everyone has to do this, but someone should.) Assume you'd have to do this process 100 times over the course of a PA. How long would you spend copying and running the file?

Part 6 – SSH Keys

So far, we've seen how to log in, run commands, and copy files to a remote server with `ssh` and `scp`. Every time we log in or run `scp`, we have to type (or copy-paste) our password. This is frustrating, time consuming, and interrupts whatever task we were trying to do. Naturally, we should look into if there are ways to avoid this repetitive, frustrating task with a configuration or program.

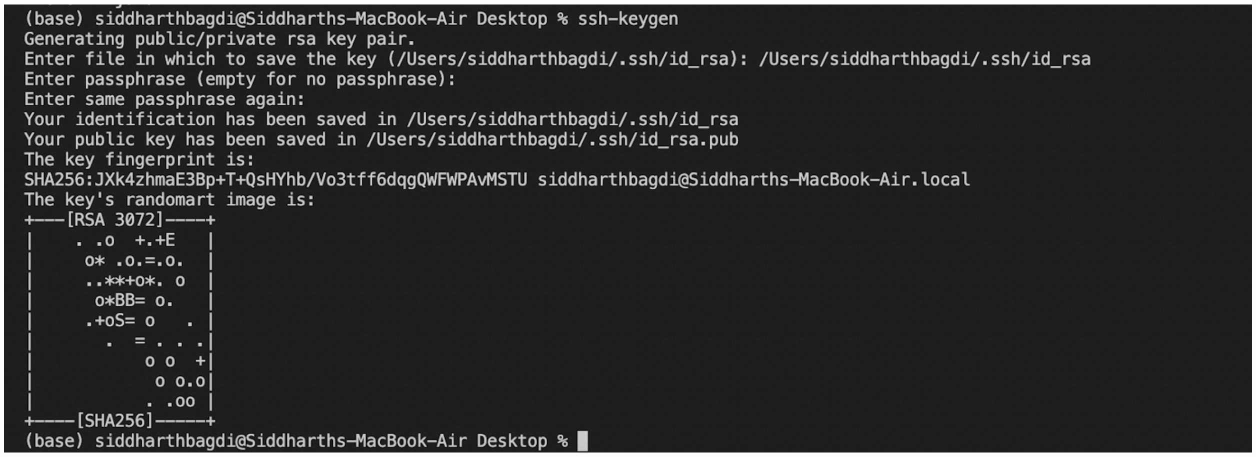
In this case, there is a great solution – `ssh` keys. The idea behind ssh keys is that a program, called `ssh-keygen`, creates a pair of files called the *public key* and *private key*. You copy the public key to a particular location on the server, and the private key in a particular location on the client. Then, the `ssh` command can use the pair of files in place of your password. This is a common setup step in lots of work environments that involve code on a server.

Here’s what you should run to set this up:

```
# on client (your computer)

$ ssh-keygen

Generating public/private rsa key pair.

Enter file in which to save the key
(/Users/<user-name>/.ssh/id_rsa): /Users/<user-name>/.ssh/id_rsa

Enter passphrase (empty for no passphrase):
```

Note: Make sure that you <u>do not add a paraphrase</u> for this step.

```
Enter same passphrase again:

Your identification has been saved in
/Users/<user-name>/.ssh/id_rsa.

Your public key has been saved in
/Users/<user-name>/.ssh/id_rsa.pub.

The key fingerprint is:

SHA256:jZaZH6fI8E2I1D35hnvGeBePQ4ELOf2Ge+G0XknoXp0
<user-name>@<system>.local

The key's randomart image is:

+---[RSA 3072]----+

|                 |

|       . . + .   |

|      . . B o .  |

|     . . B * +.. |

|      o S = *.B. |

|       = = O.*.*+|
|       + *  *.BE+|
|           +.+.o |
|             ..  |
+----[SHA256]-----+
```



```
(base) siddharthbagdi@Siddharths-MacBook-Air Desktop % ssh-keygen
Generating public/private rsa key pair.
Enter file in which to save the key (/Users/siddharthbagdi/.ssh/id_rsa): /Users/siddharthbagdi/.ssh/id_rsa
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /Users/siddharthbagdi/.ssh/id_rsa
Your public key has been saved in /Users/siddharthbagdi/.ssh/id_rsa.pub
The key fingerprint is:
SHA256:JXk4zhmaE3Bp+T+QsHYhb/Vo3tff6dqgQWFWPAvMSTU siddharthbagdi@Siddharths-MacBook-Air.local
The key's randomart image is:
+---[RSA 3072]----+
|    . .o  +.+E   |
|     o* .o.=.o.  |
|     ..**+o*. o  |
|      o*BB= o.   |
|     .+oS= o   . |
|       .  = . . .|
|           o o  +|
|            o o.o|
|           . .oo |
+----[SHA256]-----+
(base) siddharthbagdi@Siddharths-MacBook-Air Desktop %
```

If you're on Windows, follow the extra `ssh-add` steps here:

https://docs.microsoft.com/en-us/windows-server/administration/openssh/openssh_keymanagement#user-key-generation

This created two new files on your system; the private key (in a file `id_rsa`) and the public key (in a file `id_rsa.pub`), stored in the `.ssh` directory on your computer.

Now we need to copy the *public* (not the private) key to the `.ssh` directory of your user account on the server.

```
$ ssh cs15lsp22zz@ieng6.ucsd.edu

<Enter Password>

# now on server

$ mkdir .ssh

$ <logout>
```

```
# back on client

$ scp /Users/<user-name>/.ssh/id_rsa.pub
cs15lsp22zz@ieng6.ucsd.edu:~/.ssh/authorized_keys

# You use your username and the path you saw in the command
above
```

Once you do this, you should be able to `ssh` or `scp` from this client to the server without entering your password.

Write down in notes: Try to get everyone to the point where they can do this, and take a screenshot of logging in without a password. If you can't, share a screenshot and description of where you got stuck!

Write down in notes: Repeat the timing experiment of editing and running `WhereAmI.java` now that you don't have to use a password. How much time is saved per run?

Part 7 – Making Remote Running Even More Pleasant

Use what you've learned to come up with the most pleasant process you can for making a *local* edit to `WhereAmI.java`, then copying it to the remote server and running it.

Some hints:

- You can write a command in quotes at the end of an `ssh` command to directly run it on the remote server, then exit. For example, this command will log in and list the home directory on the remote server:

  ```
  $ ssh cs15lsp22zz@ieng6.ucsd.edu "ls"
  ```

- You can use semicolons to run multiple commands on the same line in most terminals. For example, try:

```
$ cp WhereAmI.java OtherMain.java; javac OtherMain.java;
java WhereAmI
```

- You can use the up-arrow on your keyboard to recall the last command that was run

Write down in notes First try using just what we learned in this lab, and document the best process you came up with. Try to get the total time for a run after editing and saving to under 10 total keystrokes/mouse clicks, including all typing.

If you have more time, brainstorm other ideas or search for other ways you might easily run remote code.

Part 8 – Wrapup

Discuss with your team – do you have any open questions about things you saw that you don’t understand? Write them down in your notes document or ask your tutor. Even if they don’t know, writing them down means we can come back to them later!

If you *didn’t* get everything to work, that’s OK! Keep trying and make sure your tutor knows if you’re totally stuck getting something set up; we’ll be posting some office hours soon where you can come to get unstuck as well.