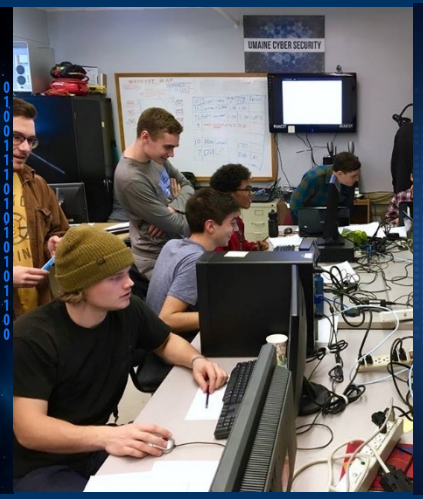
Introduction to Linux

March 24, 2023



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A Basic Introduction to Linux and Command-line

Tux the penguin, the mascot of Linux[1]

Developer	Community contributors, Linus Torvalds
Written in	C, assembly languages, and others
OS family	Unix-like
Working state	Current
Source model	Open source
Initial release	September 17, 1991; 31 years ago
Repository	git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git/

What is Linux

- Unix-like computer operating system

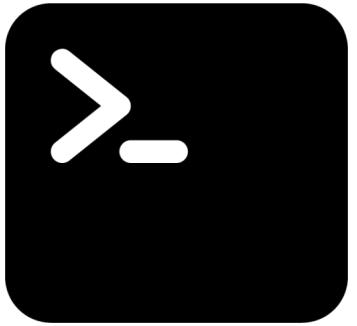
- One of the most prominent examples of free software and open-source development

  -Underlying source code can be freely modified, used, and redistributed by anyone

What is the Terminal?

- In Linux there are GUIs (graphical user interfaces)
  - where you can point and click and drag

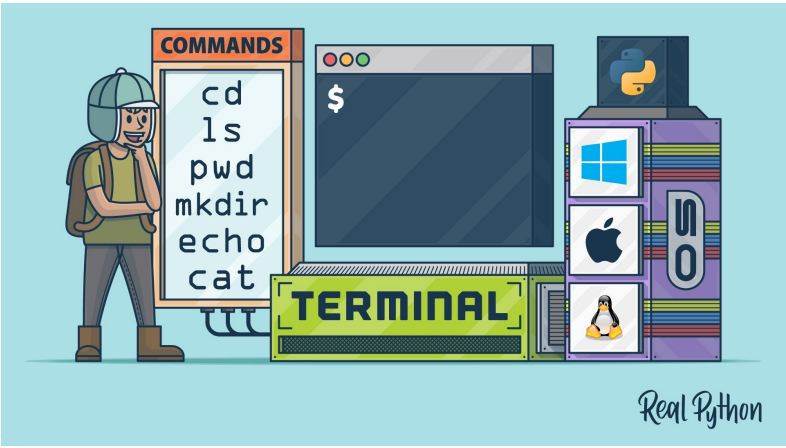
- The traditional Unix environment is a CLI (command line interface)
  - where you type commands to tell the computer what to do
  - faster and more powerful, but requires knowing the commands



- The terminal = command line interface = shell that gives command to the OS

- A ‘shell’ is a program that interprets commands so the OS can understand them

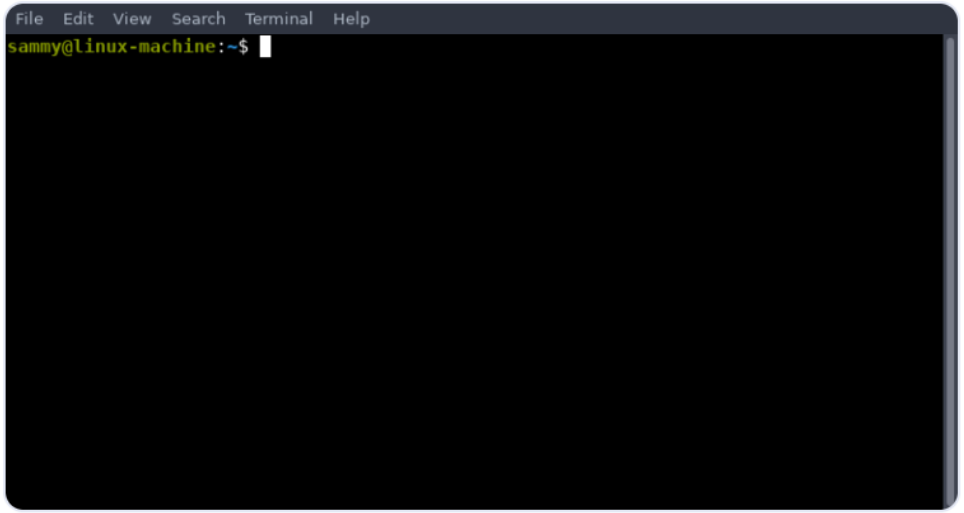
- ‘BASH’ is the default shell



Accessing Terminal on your local computer

- If you are on a Mac, you have a Bash terminal pre-installed on your computer

- If you are on a PC, you can install terminal emulators free online
  - PuTTY – Most popular (https://www.putty.org)
  - Xshell
  - Cmder



https://ondemand.osc.edu/

Ohio Supercomputer Center

An OH·TECH Consortium Member

Log in with your OSC username and password.

This system is for the use of authorized users only. Individuals using this computer system without authority, or in excess of their authority, are subject to having all of their activities on this system monitored and recorded by system personnel. In the course of monitoring individuals improperly using this system, or in the course of system maintenance, the activities of authorized users may also be monitored. Anyone using this system expressly consents to such monitoring and is advised that if such monitoring reveals possible evidence of criminal activity, system personnel may provide the evidence of such monitoring to law enforcement officials.

If making changes to your OSC user account, please allow up to 20 minutes for the changes to take effect. This includes password changes, group membership changes, and new users having login ability to OSC systems using SSH or OnDemand.

Username

Password

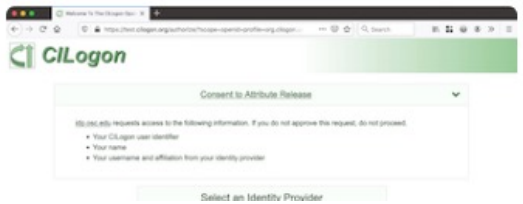
Remember me

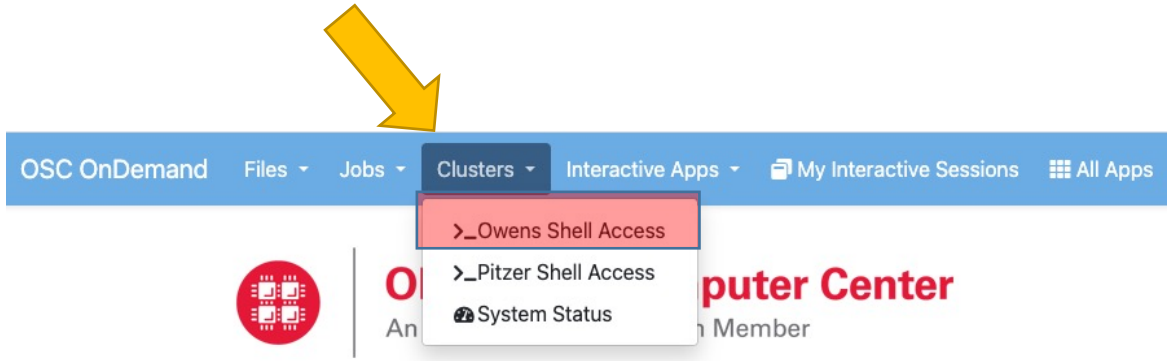
Log in with your OSC account

Log in with third party through CILogon

Step 1. Choose your identity provider

CILogon provides access to identity providers from many academic institutions across the state.






```
   officials.

*********************************************************************************
Last login: Wed Mar 22 12:01:29 2023 from web02.hpc.osc.edu
*********************************************************************************
Welcome to the Ohio Supercomputer Center!
PLEASE SEE THE OSC SUPERCOMPUTING DOCUMENTATION
FOR UP-TO-DATE INFORMATION ON OUR RESOURCES:
https://www.osc.edu/services/cluster_computing
For questions or assistance, contact oschelp@osc.edu

To check for currently known issues, please visit
https://www.osc.edu/resources/technical_support/known_issues
and follow @HPCNotices on Twitter.
*********************************************************************************
2020/03/16
--- OSC Classroom Support

CLASSROOM RESOURCES FOR DISTANCE LEARNING

If your class has lost or limited access to computer labs, the Ohio
Supercomputer Center might be able to help by providing no-cost access
to cloud computing resources. Classes and workloads of any size can
gain access. OSC's web-browser interface to its substantial Linux
computer systems provides novice users with virtual desktops preloaded
with applications, such as MATLAB, RStudio, or Jupyter Notebook.

As an example, an OSU undergrad statistics class recently used iPads
to remotely access RStudio on OSC systems. We can provide online
demonstrations or evaluations and potentially add additional software
packages.

Please contact OSCHelp@osc.edu to talk to OSC about distance-learning
support options available to you.

*********************************************************************************


Your primary project is the only group quota reported here.
See http://osc.edu/check-quotas to learn how to check the group storage quotas for your other projects.

As of 2023-03-22T14:40:01.000000 userid lmjack on /fs/ess/PUOM0014 used 13 GiB of quota 0 GiB and 419 f
As of 2023-03-22T14:40:01.000000 userid lmjack on /fs/ess/PUOM0015 used 0 GiB of quota 0 GiB and 1 file
As of 2023-03-22T14:40:01.000000 userid lmjack on /fs/ess/PUOM0012 used 0 GiB of quota 0 GiB and 1 file
As of 2023-03-22T14:42:10.000000 userid lmjack on /users/PYS1047 used 22.38 GiB of quota 500 GiB and 36

-bash-4.2$
```

Command	Description
`pwd`	Prints Current Working Directory
`ls`	Lists the contents of a directory
`cd`	Change the current path to the destination directory
`mkdir`	Makes a new directory
`rmdir`	Removes an empty directory
`cp`	Copy file or directory
`mv`	Move/Rename file or directory
`rm`	Delete file or directory
`cat`	Concatenates and prints the contents a file
`--help`	Provides help information when used with any command
`echo`	Write arguments to the standard output
`wc`	word, line, character, and byte count
`man`	Search and open the manual page of a Linux command
`more`	Paging through text one screenful at a time
`less`	Improved version of more allows backward/forward movement
`head`	Display first lines of a file
`tail`	Display last lines of a file
`grep`	Print lines in a file matching a pattern
`history`	See the commands you have typed so far

THE UNIVERSITY OF MAINE

Command-line Cheat Sheet and Resources

- https://cheatography.com/davechild/cheat-sheets/linux-command-line/
- https://datacarpentry.org/shell-genomics/
- https://swcarpentry.github.io/shell-novice/
- https://www.codecademy.com/learn/introduction-to-linux
- https://www.tutorialspoint.com/unix/index.htm

Unix/Linux Command Reference

FOSSwire.com

File Commands

ls – directory listing
ls -al – formatted listing with hidden files
cd *dir* - change directory to *dir*
cd – change to home
pwd – show current directory
mkdir *dir* – create a directory *dir*
rm *file* – delete *file*
rm -r *dir* – delete directory *dir*
rm -f *file* – force remove *file*
rm -rf *dir* – force remove directory *dir* *
cp *file1 file2* – copy *file1* to *file2*
cp -r *dir1 dir2* – copy *dir1* to *dir2*; create *dir2* if it doesn't exist
mv *file1 file2* – rename or move *file1* to *file2* if *file2* is an existing directory, moves *file1* into directory *file2*
ln -s *file link* – create symbolic link *link* to *file*
touch *file* – create or update *file*
cat > *file* – places standard input into *file*
more *file* – output the contents of *file*
head *file* – output the first 10 lines of *file*
tail *file* – output the last 10 lines of *file*
tail -f *file* – output the contents of *file* as it grows, starting with the last 10 lines

Process Management

ps – display your currently active processes
top – display all running processes
kill *pid* – kill process id *pid*
killall *proc* – kill all processes named *proc* *
bg – lists stopped or background jobs; resume a stopped job in the background
fg – brings the most recent job to foreground
fg *n* – brings job *n* to the foreground

File Permissions

chmod *octal file* – change the permissions of *file* to *octal*, which can be found separately for user, group, and world by adding:

- 4 – read (r)
- 2 – write (w)
- 1 – execute (x)

Examples:
chmod 777 – read, write, execute for all
chmod 755 – rwx for owner, rx for group and world
For more options, see **man chmod**.

SSH

ssh *user@host* – connect to *host* as *user*
ssh -p *port user@host* – connect to *host* on port *port* as *user*
ssh-copy-id *user@host* – add your key to *host* for *user* to enable a keyed or passwordless login

Searching

grep *pattern files* – search for *pattern* in *files*
grep -r *pattern dir* – search recursively for *pattern* in *dir*
command* | grep *pattern – search for *pattern* in the output of *command*
locate *file* – find all instances of *file*

System Info

date – show the current date and time
cal – show this month's calendar
uptime – show current uptime
w – display who is online
whoami – who you are logged in as
finger *user* – display information about *user*
uname -a – show kernel information
cat /proc/cpuinfo – cpu information
cat /proc/meminfo – memory information
man *command* – show the manual for *command*
df – show disk usage
du – show directory space usage
free – show memory and swap usage
whereis *app* – show possible locations of *app*
which *app* – show which *app* will be run by default

Compression

tar cf *file.tar files* – create a tar named *file.tar* containing *files*
tar xf *file.tar* – extract the files from *file.tar*
tar czf *file.tar.gz files* – create a tar with Gzip compression
tar xzf *file.tar.gz* – extract a tar using Gzip
tar cjf *file.tar.bz2* – create a tar with Bzip2 compression
tar xjf *file.tar.bz2* – extract a tar using Bzip2
gzip *file* – compresses *file* and renames it to *file.gz*
gzip -d *file.gz* – decompresses *file.gz* back to *file*

Network

ping *host* – ping *host* and output results
whois *domain* – get whois information for *domain*
dig *domain* – get DNS information for *domain*
dig -x *host* – reverse lookup *host*
wget *file* – download *file*
wget -c *file* – continue a stopped download

Installation

Install from source:
./configure
make
make install
dpkg -i *pkg.deb* – install a package (Debian)
rpm -Uvh *pkg.rpm* – install a package (RPM)

Shortcuts

Ctrl+C – halts the current command
Ctrl+Z – stops the current command, resume with **fg** in the foreground or **bg** in the background
Ctrl+D – log out of current session, similar to **exit**
Ctrl+W – erases one word in the current line
Ctrl+U – erases the whole line
Ctrl+R – type to bring up a recent command
!! - repeats the last command
exit – log out of current session

* use with extreme caution.

Navigating Directories

Using the `pwd` command

- pwd means “print working directory”
- Use this any time you want to see what folder your are currently working in

Using the **`cd`** command

- cd stands for “change directory”, you use it to navigate to different folders

  `cd` or **`cd ~`** = takes you to the home directory

Note: In Linux, a tilde (~) is shorthand for the home directory of the user you’re logged in as.

`cd ..` = takes you up one directory level (i.e., from subfolder, to parent folder)

`cd ../..` = takes you up two directory levels

`cd /fs/scratch/PUOM0012` = takes you to the specified directory

Making New directories

Using the `mkdir` command

- Example 1: make a new directory

```
mkdir test_folder1
```

- Example2: make a new directory and move into it using a single command

```
mkdir test_folder2 && cd $_
```

- Example3: make a new folder, subfolder, and sub-subfolder

```
mkdir -p test_folder3/subfolder/new_dir
```

```
macbook:Desktop laura.jackson$ tree test_folder3/
test_folder3/
└── subfolder
    └── new_dir

3 directories, 0 files
```

Moving and Copying Files

- Using the `mv` command to move
- Using the `cp` command to copy

- Basic structure of command (*use –R for recursive if moving folder plus contents)

- {command} –R /path/to/file /path/to/destination

- Copies folder1 and all contents into a subdirectory of folder 2

```
cp -R folder3 folder1
```

- Moves all .txt files from folder1 into folder3; combines wildcard *

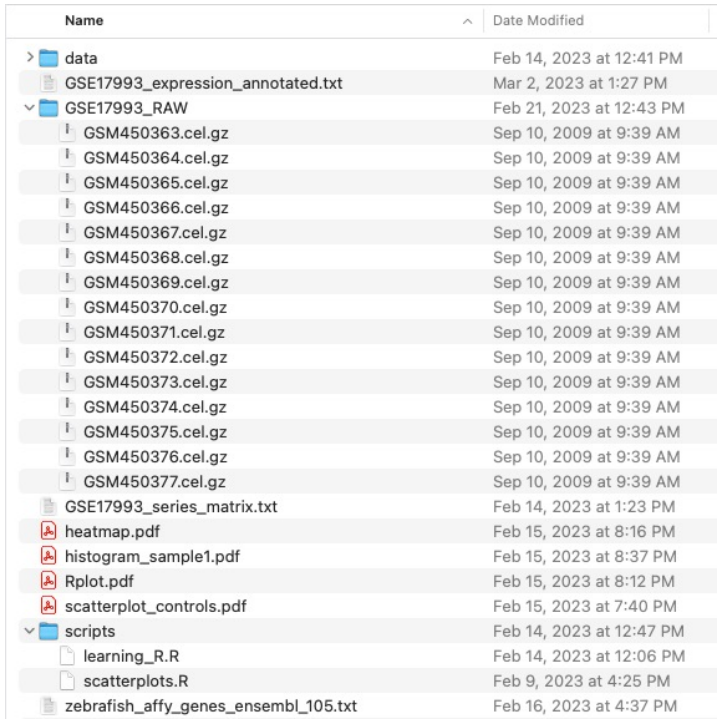
```
mv -R folder1 folder2
```

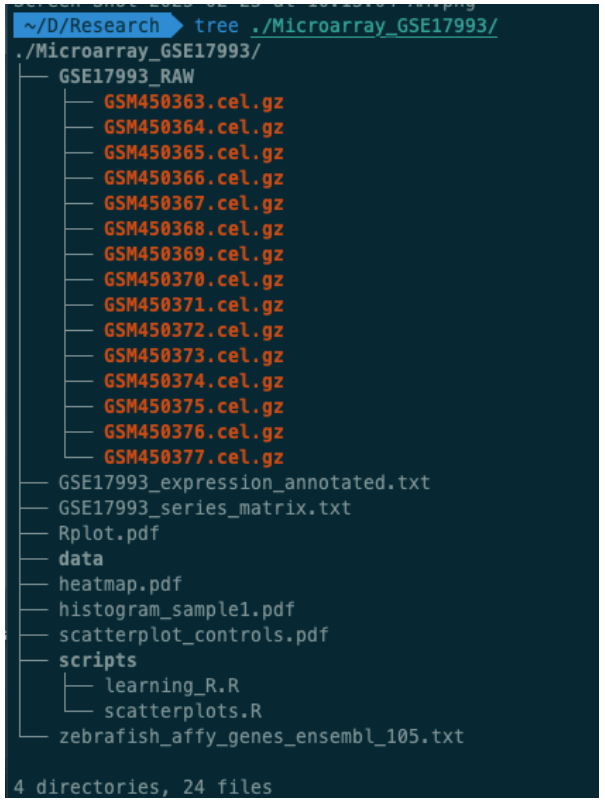
COPY training folder and all contents:

`cp -R /fs/ess/PUOM0012/linux ~/` *Check with `cd ~/linux` then `ls`

File View – GUI vs. Command-line

- Using the **`tree`** command to view directories and files





The List Command

Useful options for the `ls` command

- Used to list files or directories; often includes a “flag”

```
ls [-flag]
```

`ls -la` = List all files including hidden; beginning with a period “.”

`ls -ld` = List details about a directory and not its contents

`ls -lh` = Give human readable file sizes

`ls -R` = lists all files and subdirectory files (*R means recursive)

- Can also be combined with a directory path: ls [flags] [directory]

```
ls /path/to/folder
```

Viewing Files

Using the **head** and **tail** command

- Writes the first 10 lines by default
- Use the **-n** option to specify number of lines

```
head [options] FILE
tail [options] FILE
```

Example1: `head -4 file1.txt`

Example2: `head -2 file1.txt file2.txt`

Example3: `tail -n +10 file2.txt` *This prints everything from 10th line to end

How to edit text files in Linux?

- There are many text editors available on Linux
  - **`nano`** is a small, simple and friendly editor
  - **`vi/vim`** is a powerful text editor which can be used to edit all kinds of text
  - **`emacs`** is part of the GNU project written by Richard Stallman

- In this training course we will cover **`nano`** and **`vi/vim`**
- Let's look into **`nano`** *(Demo)*

```
nano file1.txt
```

Searching for Matching Patterns

Using the **grep** command

- Means 'global regular expression print'; search for matching pattern in file

Example1: Search for text pattern in file *includes partial match

```
grep "line" file1.txt
```

Example2: Find exact match with –w flag

```
grep -w "seds" file2.txt
```

Example3: Ignore case-sensitive

```
grep –i "this" file1.txt
```
vs.
```
grep –w "this" file1.txt
```

Example4: Count the number of patterns (*you can combine flags)

```
grep –c "this" file1.txt
```
vs.
```
grep –i –c "this" file1.txt
```

Redirecting Output to a File

Using the “>” and “>>” command

- A single > operator will overwrite the file content
- A double >> operator will save multiple outputs to a single file

Example 1: List all files and directories and output it to a text document

```
ls > directories.txt
```

Example2: Output your entire command history

```
history > commands.txt
```

Removing directories

Using the remove `rm` command

- Example 1: remove an empty directory

```
rmdir test_folder1
rmdir test_folder3 **Doesn't work because it contains files
```

- Example2: remove a directory and all files/folders within it

```
rm -R test_folder1
```

Downloading files from internet

Using the **wget** command

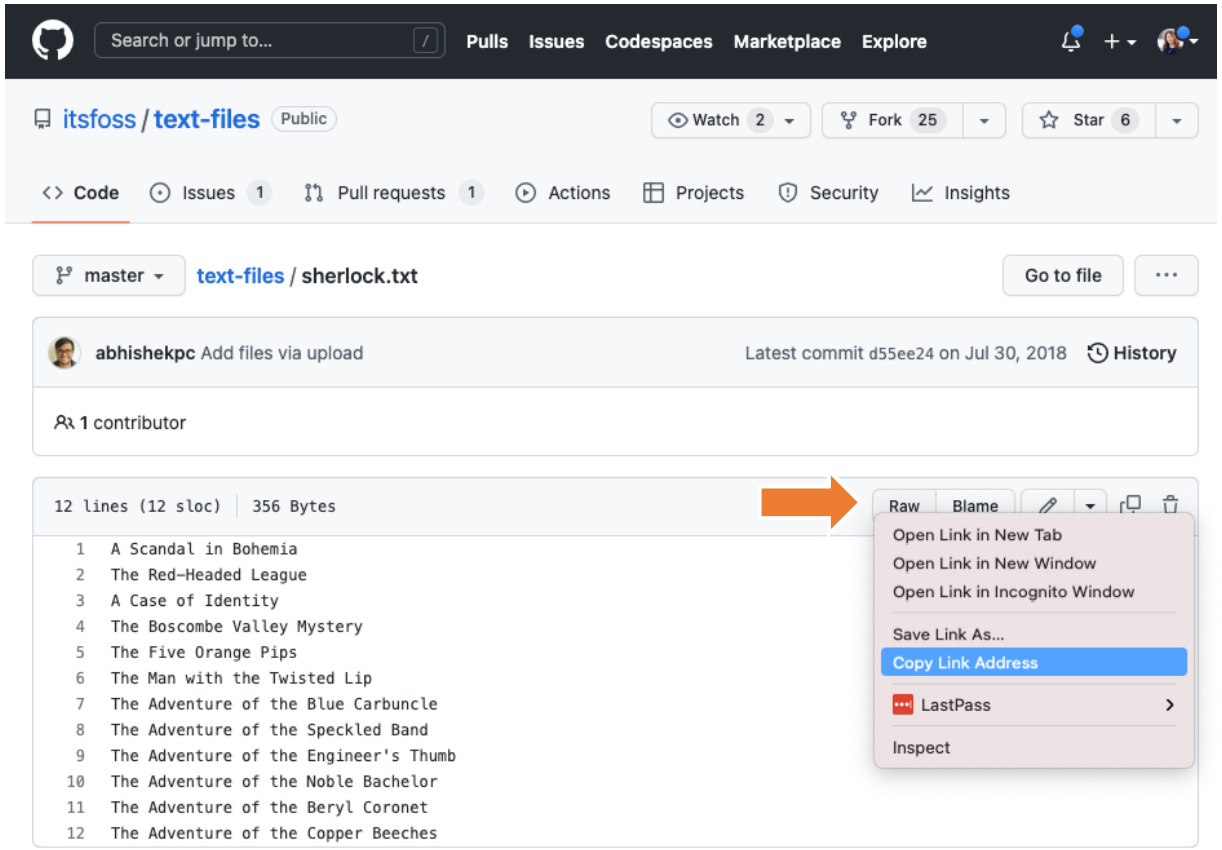
- wget command downloads files from internet
- -O : (capital O) defined the name of the destination file on your system
  - This is optional, if you want to name your file something different

```
wget [url to file] -O [what you want your file to be called]
```

```
~/Desktop wget https://repo.anaconda.com/miniconda/Miniconda3-
          latest-Linux-x86_64.sh -O miniconda3.sh
```

Downloading files from Github

- Using the **`wget`** command
  - Right click on the Raw button for a file of interest
  - Copy link address to use with the **`wget`** command



Find all files that match a given format

- Using the * command

- * can be used as a wildcard to search for partial names

- I want to search a folder for all files ending in .R
  - Quickly returns all files with a given name or format
  - I.e., *.fastq - can be used to return all fastq files in a given directory
  - Can also be used with a command to run only a certain file type

  Example1: list all .fastq files

  ```
  ls *.fastq
  ```

  Example2: list all R scripts ending in .R

  ```
  ls *.R
  ```

File/Directory Ownership and Permissions:

- Every file/directory belongs to a specific user or a group of users
- Every user/group many have permissions to `read`, `write`, &/or `execute`

owner	group	others
r w x	**r w x**	**r w x**

- If you set **`read`** permission for a directory you can create new entries
- If you set **`write`** permission for a directory you can list (ls) the contents
- If you set **`execute`** permission for a directory you can cd into the directory

```
-bash-4.2$ ls -l
total 15489
-rw-rw----+ 1 lmjack PYS1047     101 Mar 24 10:40 file1.txt
-rw-rw----+ 1 lmjack PYS1047     607 Mar 24 10:43 file2.txt
-rw-rw----+ 1 lmjack PYS1047      25 Mar 24 10:40 script.py
-rw-rw----+ 1 lmjack PYS1047      40 Mar 24 10:40 script.R
-rw-rw----+ 1 lmjack PYS1047 9876861 Mar 24 10:40 SRR14460237_R1.fastq
-rw-rw----+ 1 lmjack PYS1047 5912327 Mar 24 10:40 SRR14460237_R2.fastq
drwxrwx---+ 2 lmjack PYS1047    4096 Mar 24 11:17 test_folder
```

File/Directory Ownership and Permission Examples:

- **chmod** command changes the **rwx** mode bits of a file or directory
  - **+/–**: adds or removes the mode bits
  - **o**: Sets the permissions for the owner of the file/directory
  - **g**: Sets the permissions for the group that of the owner belongs to
  - **a**: Sets the permissions for the all other users

Example: Change file1.txt to have group execute permission

```
chmod g+x file1.txt
```

Example: Change file2.txt to remove group write permission

```
chmod g-w file2.txt
```

Mission Impossible: Reviewing what we learned

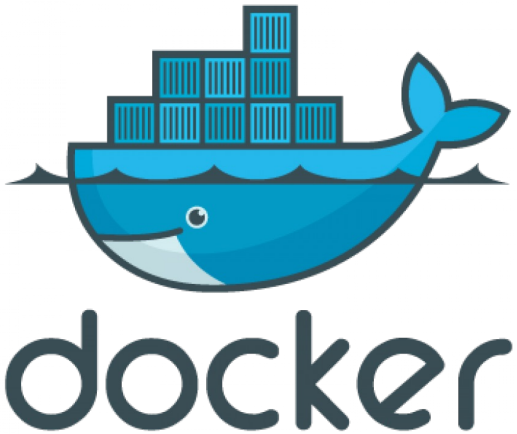
1. Go to your home directory
   `cd` or `cd /path/to/home`
2. Make a new directory called mission_impossible and move into it
   `mkdir mission_impossible && cd $_`
3. Copy a file from this url (https://github.com/itsfoss/text-files/raw/master/sherlock.txt) and call it 'poem.txt'
   `wget url -O bad_poem.txt` **check if it's there using `ls`
4. Open the file using a text editor and modify your name and date
   `nano bad_poem.txt` > edit text
5. Save your file as good_poem.txt and close
   ctrl+x > 'y' > change to good_poem.txt > enter+y
6. Verify your new edits using diff [`diff {file1} {file2}`] and save to edits.txt
   `diff bad_poem.txt good_poem.txt > edits.txt`

Part 2: Introduction to HPC on OSC

March 31 12:00pm– 1:00pm

Package managers for containerized environments

- Installing new software on HPC
- Use different software versions



Shell scripts and submitting jobs to a schedular

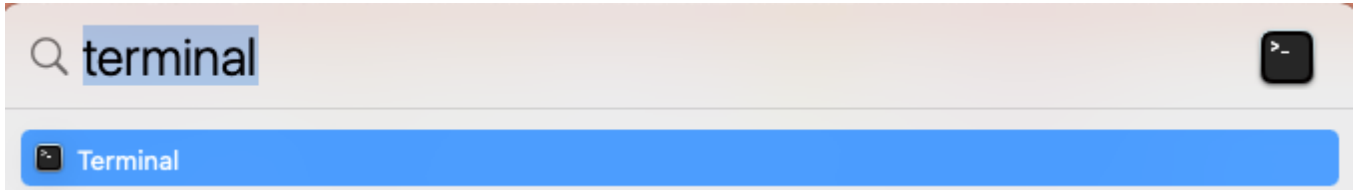
Running an interactive job using command line

Required for Workshop Part 2

You will need to have a terminal installed on your computer

Mac Users: a terminal is pre-installed

-Search for terminal using your finder to find this application icon



PC/Windows Users: you will need to download a free terminal software

-PuTTY is the recommended option, use the (v0.78) 64-bit x86 option

- https://www.putty.org