

# Introduction to Unix

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# 1 Justification

Unix, in particular Linux, is the *de facto* operating system in High-Performance Computing (HPC).

# Files and such

## 2 `ls`, `touch`

- List files: `ls`
- Maybe your account is still empty: do `touch newfile`, then `ls` again.
- Options: `ls -l` or for specific file `ls -l newfile`.

### 3 Display / add to file: cat

- Display a file: `cat myfile`
- Put something in a file: `cat > myfile`  
end with Control-D.  
Or use an editor, but this is sometimes still useful.
- Now `cat` it again.
- Do `cat >> myfile` and enter some text. What did this do?

## 4 **cp, mv, rm**

- Copy: `cp file1 file2`  
Do this, check that it's indeed a copy.
- Rename or 'move': `mv file1 file2`  
check that the original file doesn't exist any more.
- Remove: `rm myfile`  
This is irrevocable!

## 5 Dealing with large (text) files

- If a file is larger than your screen:

`less yourfile`

- If the start or end is interesting enough:

`head yourfile, tail yourfile`

- Explore options: `head -n 5 yourfile`



# Exercise 1: Put the pieces together

How would you display the 3rd line of a file?

# Directories

## 6 Directories

- Make a subdirectory 'folder': `mkdir newdir`
- Check where you are: `pwd`
- Now go to the new directory: `cd newdir` and `pwd`  
'change directory' and 'present working directory'
- Back to your home directory: `cd` without further arguments.

# 7 Paths

- Do:
  1. `cd newdir`
  2. `touch nested_file`
  3. `cd`
- Now: `ls newdir/nested_file`
- That is called a path
  - Relative path: does not start with slash
  - Absolute path (such as `pwd` output): starts at root

## 8 More paths

- Path to your home directory: tilde `cd ~`
- Current directory: `.`
- Going out of a directory: `cd ..`  
(confusing: do you call this a level up or down?)
- You can use this in paths: `ls newdir/subdir1/../subdir2`

## Exercise 2: Paths

After the following commands:

```
mkdir somedir  
touch somedir/somefile
```

Give at least two ways of specifying the path to `somefile` from the current directory for instance for the `ls` command.

Same after doing `cd somedir`

# Redirection, pipes

## 9 In/Output redirection

- There are three standard files: `stdin`, `stdout`, `stderr`
- Normally connected to keyboard, screen, and screen respectively.
- Redirection: standard out to file:  
`ls > directorycontents`  
(actually, screen is a file, so it is really a **redirect**)
- Standard in from file: `mail < myfile`  
(actually, the keyboard is also a file, so again **redirection**)



## Exercise 3:

Make a copy of a file, using redirection (so no `cp` command).

## 10 Advanced: splitting out and err

- Sometimes you want to split standard out and error:

- Use `stdout= 1` and `stderr= 2`:

```
myprogram 1>results.out 2>results.err
```

- Very useful: get rid of errors:

```
myprogram 2>/dev/null
```

# 11 Pipes

- Redirection is command-to-file.
- Pipe: command-to-command

```
ls | wc -l
```

(what does this do?)

- Unix philosophy: small building blocks, put together.

## 12 More command sequencing

More complicated case of one command providing input for another:

```
echo The line count is wc -l foo
```

where `foo` is the name of an existing file.

Use backquotes or command macro:

```
echo The line count is `wc -l foo`  
echo "There are $( wc -l foo ) lines"
```

## Exercise 4:

This way `wc` prints the file name. Can you figure out a way to prevent that from happening?

# Permissions

# 13 Basic permissions

- Three degrees of access: user/group/other
- three types of access: read/write/execute

<i>user</i>	<i>group</i>	<i>other</i>
<i>rwX</i>	<i>rwX</i>	<i>rwX</i>

Example: `rw-r-----:`

owner read-write, group read, world nothing

## 14 Permission setting

- Add permissions `chmod g+w myfile`
- recursively: `chmod -R o-r mydirectory`
- Permissions are an octal number: `chmod 644 myfile`



## 15 Share files

- Make a file in your `$WORK` file system, and make it visible to the world.
- Ask a fellow student to view it.
- $\Rightarrow$  also necessary to make `$WORK` readable.  
(Not a good idea to make `$HOME` readable.)

# 16 The x bit

The x bit has two meanings:

- For regular files: executable.
- For directories: you can go into them.
- Make all directories viewable:

```
chmod -R g+X,o+X rootdir
```

# Shell programming

# 17 Command execution

- Some shell commands are built-in, however most are programs.
- `which ls`
- Exercise: what can you find out about the `ls` program?
- Programs can be called directly: `/bin/ls` or found along the search path `$PATH`:  
`echo $PATH`

## 18 The PATH variable

- The `PATH` variable is set by the system
- You can add in the `.bashrc` file
- TACC module system ...
- Temporary:  

```
export PATH=/my/bin/dir:${PATH}
```
- Changes to `.bashrc` take effect next time you log in  
or `source .bashrc` for immediate results.

# 19 Things that look like commands

- Use `alias` to give a new name to a command:  
`alias ls='ls -F'`  
`alias rm='rm -i'`
- There is a shell level `function` mechanism, not explained here.

## 20 Processes

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<code>ps</code>	list (all) processes
<code>kill</code>	kill a process
<code>CTRL-c</code>	kill the foreground job
<code>CTRL-z</code>	suspect the foreground job
<code>jobs</code>	give the status of all jobs
<code>fg</code>	bring the last suspended job to the foreground
<code>fg %3</code>	bring a specific job to the foreground
<code>bg</code>	run the last suspended job in the background

---

Exercise: how many programs do you have running?

## 21 Variables

- `PATH` is a variable, built-in to the shell
- you can make your own variables:

```
a=5
```

```
echo $a
```

No spaces around the equals!

Exercise: what happens when you try to add two variables together?

```
a=3
```

```
b=5
```



## 22 Variable manipulation

- Often you want to strip prefixes or suffixes from a variable:

`program.c`  $\Rightarrow$  `program`

`/usr/bin/program`  $\Rightarrow$  `program`

- Parameter expansion:

`a=program.c`

`echo ${a%%.c}`

`a=/foo/bar/program.c`

`eecho ${a##*/}`

## 23 Conditionals

- Mostly text-based tests:

```
if [ $a = "foo" ] ; then
    echo "that was foo"
else
    echo "that was $a"
fi
```

- Single line:

```
if [ $a = "foo" ] ; then echo "foo" ; else echo "something" ; fi
```

**Note the semicolons!**

**also spaces around square brackets.**

## 24 Other conditionals

- Numerical tests:/

```
if [ $a -gt 2 ] ....
```

- File and directory:

```
if [ -f $HOME ] ; then echo "exists" ; else echo "no such" ; fi  
if [ -d $HOME ] ; then echo "directory!" ; else echo "file" ; fi
```

## 25 Looping

- Loop: for item in list

the item is available as macro

```
for letter in a b c ; do echo $letter ; done
```

- Loop over files:

```
for file in * ; do echo $file ; done
```

### Exercises:

1. for each file, print its name and how many lines there are in it.
2. loop through your files, print which ones are directories.
3. for each C program, remove the object file.

## 26 Numerical looping

- Type `seq 1 5`
- Exercise: can you figure out how to loop `1...5`?

```
n=12
## input
for i in ..... ; do echo $i ; done
## output
1
....
12
```

# Scripting

## 27 Script execution

- Create a script `script.sh`:

```
#!/bin/bash  
echo foo
```

- Can you execute this? Does the error suggest a remedy?
- What is the remaining problem?

## 28 Arguments

- You want to call `./script.sh myfile`
- Parameters are `$1` et cetera:  

```
#!/bin/bash  
echo "$1 is a file"
```
- How many arguments: `$#`



## 29 Exercise

Write a script that takes as input a file name argument, and reports how many lines are in that file.

Edit your script to test whether the file has less than 10 lines (use the `foo -lt bar test`), and if it does, `cat` the file.

Add a test to your script so that it will give a helpful message if you call it without any arguments.

## 30 Exercise

Write a 'plagiarism detector'.

- Write a script that accepts two arguments: one text file and one directory

```
./yourscript.sh myfile targetdir
```

(the `.sh` extension is required for this exercise)

- Your script should compare the text file to the contents of the directory:
  - If the file is different from anything in the directory, it should be copied into the directory; the script should not produce any output in this case.
  - If the file is the same as a file in the directory, the script should complain.
  - The test whether files are 'the same' should be made with the `diff` command. Explore options that allow `diff` to ignore differences that are only in whitespace.

## 31 Turn it in!

Here is how you submit your homework.

- There is a test/submit script:

```
sds_plagiarism yourscript.sh
```

This tests the correctness of your script.

- If your script passes the test, use the `-s` option to submit:

```
sds_plagiarism -s yourscript.sh
```

or use the `-i` option to submit incomplete:

```
sds_plagiarism -i yourscript.sh
```

- Add the `-d` option for some debugging output:

```
sds_plagiarism -d yourscript.sh
```

- (after you run the script once, you'll see in your directory the files that are used for testing)