

# Introduction to Unix

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# Justification

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

# Files and such

# 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`.

## 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?

## **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!

# 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

# 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.

# 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
- Create multiple directories:  
`mkdir -p sub1/sub2/sub3` (p for 'parent')

# More paths

- Path to your home directory: tilde `cd ~`
- Current directory: `.`
- One level back: `..`  
Example: 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`

## Exercise 3: Relative moving

```
mkdir -p sub1/sub2/sub3  
cd sub1/sub2/sub3  
touch a
```

You now have a file `sub1/sub2/sub3/a`

1. How do you move it to `sub1/sub2/a`?
2. Go: `cd sub1/sub2`

How do you now move the file to `sub1/a`?

# Redirection, pipes



# In/Output redirection

Output into a file:

```
ls -l > listing
```

Append:

```
ls dir1 > dirlisting  
ls dir2 >> dirlisting
```

Input:

```
myprogram < myinput
```

## Exercise 4:

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

Can you use both `>` and `<`?

# Redirection, formal aspects

- There are three standard files: 'standard input/output/error' (available in C/C++ as `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**)

## 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`

# Pipes

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

```
ls | wc -l
```

(what does this do?)

- Unix philosophy: small building blocks, put together.

## 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 5: All the pieces together

Generate a text file that contains your information:

```
My user name is:  
eijkhout  
My home directory is:  
/users/eijkhout  
I made this script on:  
isp.tacc.utexas.edu
```

where you use the commands `whoami`, `pwd`, `hostname`. Also cut and paste into another file the part of your terminal session that generated this.

Bonus points if you can get the ‘prompt’ and output on the same line.

## Exercise 6:

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



# Permissions

# 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

# Permission setting

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

# 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.)

# 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

# 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`

# 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.



# 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.

# Processes

---

<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?

# 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
```

# 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##*/}`

# 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.**

## 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
```

# 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.

# 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

# 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?

# Arguments

- You want to call `./script.sh myfile`
- Parameters are `$1` et cetera:  
    `#!/bin/bash`  
    `echo "$1 is a file"`
- How many arguments: `$#`

# 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.

# 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.

# 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)