

Shell Basics

- Most modern tools have a graphical user interface (GUI)
- But command-line user interfaces (CLUIs) still have their place
- Easier to see and understand what the computer is doing on your behalf
- Most important: it's easier to combine CLUI tools than GUI tools

How to tell if you can skip this lecture

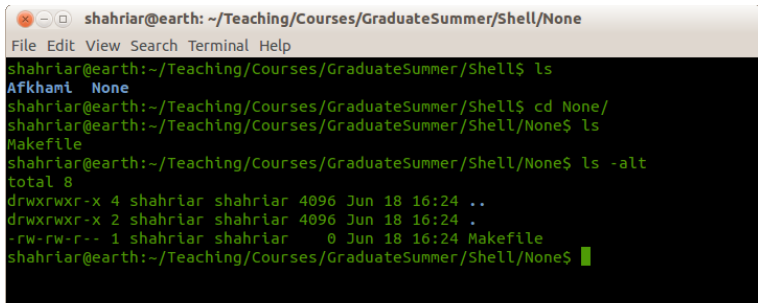
- Do you know what a shell is?
- Do you know the difference between an absolute path and a relative path?
- Do you know what a process is?
- Do you know what a pipe is?
- Do you know what \$PATH is?
- Do you know what rwxr-xr-x means?

Kernighan & Pike 1984, still a good book despite its age

The command shell

Manages a user's interactions with the operating system by:

- Reading commands from the keyboard
- Figuring out what programs the user wants to run
- Running those programs
- Displaying their output on the screen
- Looks (and works) like an interactive terminal:



```
shahriar@earth: ~/Teaching/Courses/GraduateSummer/Shell/None
File Edit View Search Terminal Help
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ ls
Afkhami  None
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ cd None/
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls
Makefile
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -alt
total 8
drwxrwxr-x 4 shahriar shahriar 4096 Jun 18 16:24 ..
drwxrwxr-x 2 shahriar shahriar 4096 Jun 18 16:24 .
-rw-rw-r-- 1 shahriar shahriar    0 Jun 18 16:24 Makefile
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ █
```

We'll use bash:

- Output can be redirected using `>` and `<`.
- Commands can be combined using pipelines.
- The history command can be used to view and repeat previous operations, while tab completion can be used to save re-typing.
- Directories (or folders) are nested to organize information hierarchically.
- Use `grep` to find things in files, and `find` to find files themselves.
- Programs can be paused, run in the background, or run on remote machines.
- The shell has variables like any other program, and these can be used to control how it behaves.

- The file system is the set of files and directories the computer can access
- Everything in a particular directory must have a unique name
- On Unix, the file system has a unique root directory called /
- Every other directory is a child of it, or a child of a child, etc.
- A path is a description of how to find something in a file system
- An absolute path describes a location from the root directory down
- A relative path describes how to find something from some other location

A Few Simple Commands

Most Unix commands have cryptic names

pwd	print working directory
ls	listing
cd	changing working directory
.	current directory
..	parent directory: directory immediately above this one

By convention, flags start with "-", as in "-c" or "-l"

ls -F

ls -a

ls -Fa

ls -s

```
shahriar@earth: ~/Teaching/Courses/GraduateSummer/Shell/None
File Edit View Search Terminal Help
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ pwd
/home/shahriar/Teaching/Courses/GraduateSummer/Shell/None
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ cd ..
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ ls
Afkhami  None
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ ls -F
Afkhami/  None/
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ ls -F -a
./  ../  Afkhami/  None/
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ whoami
shahriar
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ date
Tue Jun 18 17:24:40 EDT 2013
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ cd None/
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -Fa
./  ../  Makefile
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -atls
total 8
4 drwxrwxr-x 4 shahriar shahriar 4096 Jun 18 16:24 ..
4 drwxrwxr-x 2 shahriar shahriar 4096 Jun 18 16:24 .
0 -rw-rw-r-- 1 shahriar shahriar    0 Jun 18 16:24 Makefile
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ touch myfile.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -atl
total 8
drwxrwxr-x 2 shahriar shahriar 4096 Jun 18 17:28 .
-rw-rw-r-- 1 shahriar shahriar    0 Jun 18 17:28 myfile.txt
drwxrwxr-x 4 shahriar shahriar 4096 Jun 18 16:24 ..
-rw-rw-r-- 1 shahriar shahriar    0 Jun 18 16:24 Makefile
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ touch myfile.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -atl
total 8
-rw-rw-r-- 1 shahriar shahriar    0 Jun 18 17:29 myfile.txt
drwxrwxr-x 2 shahriar shahriar 4096 Jun 18 17:28 .
drwxrwxr-x 4 shahriar shahriar 4096 Jun 18 16:24 ..
-rw-rw-r-- 1 shahriar shahriar    0 Jun 18 16:24 Makefile
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$
```

mkdir	creating directory
cp	copy a file
nano	text editor
rm	delete a file
rmdir	delete a directory
mv	move or rename a file or directory
wc	word count
cat	catenate file

It's important to remember that there is no undelete.


```
shahriar@earth: ~/Teaching/Courses/GraduateSummer/Shell/None
File Edit View Search Terminal Help
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ mkdir tmp
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -F
Makefile myfile.txt tmp/
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ pwd
/home/shahriar/Teaching/Courses/GraduateSummer/Shell/None
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -a tmp/
.
..
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ nano junk
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls
junk Makefile myfile.txt tmp
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -s
total 12
4 junk 0 Makefile 4 myfile.txt 4 tmp
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -s -h
total 12K
4.0K junk 0 Makefile 4.0K myfile.txt 4.0K tmp
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ rm tmp/
rm: cannot remove `tmp/': Is a directory
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ rmdir tmp/
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -Fa
./ ../ junk Makefile myfile.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ mkdir tmp
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ mv junk junk.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ mv junk.txt tmp/
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ cp myfile.txt tmp/
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ wc tmp/myfile.txt
 2  6 47 tmp/myfile.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls *.txt
myfile.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ cp myfile.txt file.
txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls ?????.*
file.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ █
```

```
shahriar@earth: ~/Teaching/Courses/GraduateSummer/Shell/None
File Edit View Search Terminal Help
GNU nano 2.2.6 File: junk Modified
This is what nano looks like when it runs.
^G Get Help ^O WriteOut ^R Read File ^Y Prev Page ^K Cut Text ^C Cur Pos
^X Exit ^J Justify ^W Where Is ^V Next Page ^U UnCut Text ^T To Spell
```

Some useful commands

```
shahriar@earth: ~/Teaching/Courses/GraduateSummer/Shell/None
File Edit View Search Terminal Help
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ nano myscripts.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -F
file.txt Makefile myfile.txt myscripts.txt tmp/
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ cat myfile.txt
Name: Earth
Orbital Period: 365.256363004 days
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ cat myscripts.txt
Name: Earth
Period: 365.26 days
Eccentricity: 0.02

Name: Venus
Period: 224.70 days
Eccentricity: 0.01
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ wc *.txt
  2   6  47 file.txt
  2   6  47 myfile.txt
  7  14 103 myscripts.txt
 11  26 197 total
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ wc -l *.txt
  2 file.txt
  2 myfile.txt
  7 myscripts.txt
 11 total
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ wc -w *.txt
  6 file.txt
  6 myfile.txt
 14 myscripts.txt
 26 total
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ wc -c *.txt
 47 file.txt
 47 myfile.txt
103 myscripts.txt
197 total
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$
```

The real strength of the shell is its ability to combine simple utilities in useful ways.

>	redirect the output to a file
<	redirect the input to a file
	pipe/connect processes together
*	pattern-matching wildcard
?	matches any single character

```
shahriar@earth: ~/Teaching/Courses/GraduateSummer/Shell/None
File Edit View Search Terminal Help
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ wc -l *.txt
 2 file.txt
 2 myfile.txt
 7 myscripts.txt
11 total
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ wc -l *.txt > lengths
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls
file.txt lengths Makefile myfile.txt myscripts.txt tmp
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ cat lengths
 2 file.txt
 2 myfile.txt
 7 myscripts.txt
11 total
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ head -1 lengths
 2 file.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ tail lengths
 2 file.txt
 2 myfile.txt
 7 myscripts.txt
11 total
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ tail lengths | head -1
 2 file.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -atl
total 28
-rw-rw-r-- 1 shahriar shahriar 56 Jun 19 12:33 lengths
drwxrwxr-x 3 shahriar shahriar 4096 Jun 19 12:33 .
-rw-rw-r-- 1 shahriar shahriar 103 Jun 19 12:28 myscripts.txt
-rw-rw-r-- 1 shahriar shahriar 47 Jun 19 11:26 file.txt
drwxrwxr-x 2 shahriar shahriar 4096 Jun 19 11:14 tmp
-rw-rw-r-- 1 shahriar shahriar 47 Jun 18 17:53 myfile.txt
drwxrwxr-x 4 shahriar shahriar 4096 Jun 18 16:24 ..
-rw-rw-r-- 1 shahriar shahriar 0 Jun 18 16:24 Makefile
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$
```

- Use `ls` to sort its output by filename extension.
- Use `grep` to find a pattern and in a file.
- Use `diff` to display the differences between two files.
- Use `find` command to find files.
- What do the commands `pushd` and `popd` do?

Exercise

```
shahriar@earth: ~/Teaching/Courses/GraduateSummer/Shell/None
File Edit View Search Terminal Help
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -l --sort=extension
total 20
-rw-rw-r-- 1 shahriar shahriar 56 Jun 19 12:33 lengths
-rw-rw-r-- 1 shahriar shahriar 0 Jun 18 16:24 Makefile
drwxrwxr-x 2 shahriar shahriar 4096 Jun 19 11:14 tmp
-rw-rw-r-- 1 shahriar shahriar 47 Jun 19 11:26 file.txt
-rw-rw-r-- 1 shahriar shahriar 47 Jun 18 17:53 myfile.txt
-rw-rw-r-- 1 shahriar shahriar 103 Jun 19 12:28 myscripts.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ ls -l
total 20
-rw-rw-r-- 1 shahriar shahriar 47 Jun 19 11:26 file.txt
-rw-rw-r-- 1 shahriar shahriar 56 Jun 19 12:33 lengths
-rw-rw-r-- 1 shahriar shahriar 0 Jun 18 16:24 Makefile
-rw-rw-r-- 1 shahriar shahriar 47 Jun 18 17:53 myfile.txt
-rw-rw-r-- 1 shahriar shahriar 103 Jun 19 12:28 myscripts.txt
drwxrwxr-x 2 shahriar shahriar 4096 Jun 19 11:14 tmp
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ cat myscripts.txt
Name: Earth
Period: 365.26 days
Eccentricity: 0.02

Name: Venus
Period: 224.70 days
Eccentricity: 0.01
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ grep Venus *.txt
myscripts.txt:Name: Venus
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ grep Earth *.txt
file.txt:Name: Earth
myfile.txt:Name: Earth
myscripts.txt:Name: Earth
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$ grep -n Earth *.txt
file.txt:1:Name: Earth
myfile.txt:1:Name: Earth
myscripts.txt:1:Name: Earth
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell/None$
```

Exercise

```
shahriar@earth: ~/Teaching/Courses/GraduateSummer/Shell
File Edit View Search Terminal Help
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ ls -aF
./ ../ Afkhami/ None/
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ find . -name *.txt
./None/myscripts.txt
./None/file.txt
./None/myfile.txt
./None/tmp/myfile.txt
./None/tmp/junk.txt
./None/myscripts-new.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ du -a | grep txt
4      ./None/myscripts.txt
4      ./None/file.txt
4      ./None/myfile.txt
4      ./None/tmp/myfile.txt
4      ./None/tmp/junk.txt
4      ./None/myscripts-new.txt
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ wc -l `find . -name *.txt`
  7 ./None/myscripts.txt
  2 ./None/file.txt
  2 ./None/myfile.txt
  2 ./None/tmp/myfile.txt
  1 ./None/tmp/junk.txt
 11 ./None/myscripts-new.txt
 25 total
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$ grep Earth `find . -name *.txt`
./None/myscripts.txt:Name: Earth
./None/file.txt:Name: Earth
./None/myfile.txt:Name: Earth
./None/tmp/myfile.txt:Name: Earth
./None/myscripts-new.txt:Name: Earth
shahriar@earth:~/Teaching/Courses/GraduateSummer/Shell$
```


Linux Process Control

top	display Linux tasks
kill	terminate a process
ps	report a snapshot of the current processes
ctl C	kill a running job
&	run in the background
jobs	tell processes are currently running in the background
fg	brings the background job into the foreground
ctl Z	pause the job and return control to the shell (use fg or bg to res

Environment Variables

HOME	The current user's home directory
HOSTNAME	This computer's name
HOSTTYPE	What kind of computer this is
PATH	Where to look for programs
PWD	Present working directory
SHELL	What shell is being run
TEMP	Where to store temporary files
USER	The current user's ID

set

export VARNAME=value

example: PATH=\$PATH:/data/myscripts/bin