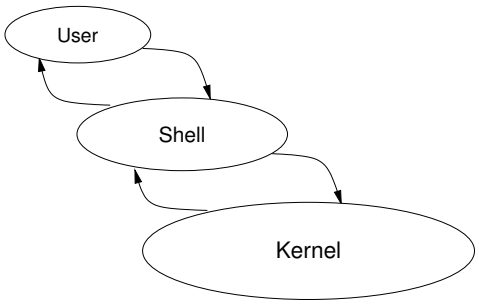
Module 3

Work Effectively on the Unix Command Line

3.1 Shells

- A **shell** provides an interface between the user and the operating system kernel
- Either a **command interpreter** or a graphical user interface
- Traditional Unix shells are **command-line interfaces** (CLIs)
- Usually started automatically when you log in or open a terminal



3.2 The Bash Shell

- Linux's most popular command interpreter is called `bash`
  - The **Bourne-Again Shell**
  - More sophisticated than the original `sh` by Steve Bourne
  - Can be run as `sh`, as a replacement for the original Unix shell
- Gives you a prompt and waits for a command to be entered
- Although this course concentrates on Bash, the shell `tcsh` is also popular
  - Based on the design of the older C Shell (`csh`)

3.3 Shell Commands

- Shell commands entered consist of words
  - Separated by spaces (whitespace)
  - The first word is the command to run
  - Subsequent words are options or arguments to the command
- For several reasons, some commands are built into the shell itself
  - Called **builtins**
  - Only a small number of commands are builtins, most are separate programs

3.4 Command-Line Arguments

- The words after the command name are passed to a command as a list of **arguments**
- Most commands group these words into two categories:
  - Options, usually starting with one or two hyphens
  - Filenames, directories, etc., on which to operate
- The options usually come first, but for most commands they do not need to
- There is a special option '`--`' which indicates the end of the options
  - Nothing after the double hyphen is treated as an option, even if it starts with `-`

3.5 Syntax of Command-Line Options

- Most Unix commands have a consistent syntax for options:
  - Single letter options start with a hyphen, e.g., `-B`
  - Less cryptic options are whole words or phrases, and start with two hyphens, for example `--ignore-backups`
- Some options themselves take arguments
  - Usually the argument is the next word: `sort -o` *`output_file`*
- A few programs use different styles of command-line options
  - For example, long options (not single letters) sometimes start with a single `-` rather than `--`

3.6 Examples of Command-Line Options

- List all the files in the current directory:

```
$ ls
```

- List the files in the 'long format' (giving more information):

```
$ ls -l
```

- List full information about some specific files:

```
$ ls -l notes.txt report.txt
```

- List full information about all the *.txt* files:

```
$ ls -l *.txt
```

- List all files in long format, even the hidden ones:

```
$ ls -l -a
$ ls -la
```

3.7 Setting Shell Variables

- **Shell variables** can be used to store temporary values
- Set a shell variable's value as follows:

```
$ files="notes.txt report.txt"
```

  - The double quotes are needed because the value contains a space
  - Easiest to put them in all the time
- Print out the value of a shell variable with the `echo` command:

```
$ echo $files
```

  - The dollar (`$`) tells the shell to insert the variable's value into the command line
- Use the `set` command (with no arguments) to list all the shell variables

3.8 Environment Variables

- Shell variables are private to the shell
- A special type of shell variables called **environment variables** are passed to programs run from the shell
- A program's **environment** is the set of environment variables it can access
  - In Bash, use `export` to export a shell variable into the environment:

```
$ files="notes.txt report.txt"
$ export files
```

  - Or combine those into one line:

```
$ export files="notes.txt report.txt"
```

- The `env` command lists environment variables

3.9 Where Programs are Found

- The location of a program can be specified explicitly:
  - `./sample` runs the `sample` program in the current directory
  - `/bin/ls` runs the `ls` command in the */bin* directory
- Otherwise, the shell looks in standard places for the program
  - The variable called `PATH` lists the directories to search in
  - Directory names are separated by colon, for example:

```
$ echo $PATH
/bin:/usr/bin:/usr/local/bin
```

  - So running `whoami` will run */bin/whoami* or */usr/bin/whoami* or */usr/local/bin/whoami* (whichever is found first)

3.10 Bash Configuration Variables

- Some variables contain information which Bash itself uses
  - The variable called `PS1` (Prompt String 1) specifies how to display the shell prompt
- Use the `echo` command with a `$` sign before a varable name to see its value, e.g.

```
$ echo $PS1
[\u@\h \W]\$
```

- The special characters `\u`, `\h` and `\W` represent shell variables containing, respectively, your user/login name, machine's hostname and current working directory, i.e.,
  - `$USER`, `$HOSTNAME`, `$PWD`

3.11 Using History

- Previously executed commands can be edited with the `Up` or `Ctrl+P` keys
- This allows old commands to be executed again without re-entering
- Bash stores a **history** of old commands in memory
  - Use the built-in command `history` to display the lines remembered
  - History is stored between sessions in the file *~/.bash_history*
- Bash uses the `readline` library to read input from the user
  - Allows Emacs-like editing of the command line
  - `Left` and `Right` cursor keys and `Delete` work as expected

3.12 Reusing History Items

- Previous commands can be used to build new commands, using **history expansion**
- Use `!!` to refer to the previous command, for example:

```
$ rm index.html
$ echo !!
echo rm index.html
rm index.html
```

- More often useful is `!`*`string`*, which inserts the most recent command which started with *`string`*
  - Useful for repeating particular commands without modification:

```
$ ls *.txt
notes.txt  report.txt
$ !ls
ls *.txt
notes.txt  report.txt
```

3.13 Retrieving Arguments from the History

- The event designator `!$` refers to the last argument of the previous command:

```
$ ls -l long_file_name.html
-rw-r--r-- 1 jeff  users   11170 Oct 31 10:47 long_file_name.html
$ rm !$
rm long_file_name.html
```

- Similarly, `!^` refers to the first argument
- A command of the form `^`*`string`*`^`*`replacement`*`^` replaces the first occurrence of *`string`* with *`replacement`* in the previous command, and runs it:

```
$ echo $HOTSNAME

$ ^TS^ST^
echo $HOSTNAME
tiger
```


3.14 Summary of Bash Editing Keys

- These are the basic editing commands by default:
  - `Right` — move cursor to the right
  - `Left` — move cursor to the left
  - `Up` — previous history line
  - `Down` — next history line
  - `Ctrl+A` — move to start of line
  - `Ctrl+E` — move to end of line
  - `Ctrl+D` — delete current character
- There are alternative keys, as for the Emacs editor, which can be more comfortable to use than the cursor keys
- There are other, less often used keys, which are documented in the `bash` man page (section 'Readline')

3.15 Combining Commands on One Line

- You can write multiple commands on one line by separating them with `;`
- Useful when the first command might take a long time:

```
time-consuming-program; ls
```

- Alternatively, use `&&` to arrange for subsequent commands to run only if earlier ones succeeded:

```
time-consuming-potentially-failing-program && ls
```

3.16 Repeating Commands with `for`

- Commands can be repeated several times using `for`
  - Structure: `for` *`varname`* `in` *`list`*`; do` *`commands...`*`; done`
- For example, to rename all *.txt* files to *.txt.old*:

```
$ for file in *.txt;
> do
>   mv -v $file $file.old;
> done
barbie.txt -> barbie.txt.old
food.txt -> food.txt.old
quirks.txt -> quirks.txt.old
```

- The command above could also be written on a single line

3.17 Command Substitution

- **Command substitution** allows the output of one command to be used as arguments to another
- For example, use the `locate` command to find all files called *manual.html* and print information about them with `ls`:

```
$ ls -l $(locate manual.html)
$ ls -l `locate manual.html`
```

- The punctuation marks on the second form are opening single quote characters, called **backticks**
  - The `$()` form is usually preferred, but backticks are widely used
- Line breaks in the output are converted to spaces
- Another example: use `vi` to edit the last of the files found:

```
$ vi $(locate manual.html | tail -1)
```

3.18 Finding Files with `locate`

- The `locate` command is a simple and fast way to find files
- For example, to find files relating to the email program `mutt`:

```
$ locate mutt
```

- The `locate` command searches a database of filenames
  - The database needs to be updated regularly
  - Usually this is done automatically with `cron`
  - But `locate` will not find files created since the last update
- The `-i` option makes the search case-insensitive
- `-r` treats the pattern as a regular expression, rather than a simple string

3.19 Finding Files More Flexibly: `find`

- `locate` only finds files by name
- `find` can find files by any combination of a wide number of criteria, including name
- Structure: `find` *`directories criteria`*
- Simplest possible example: `find .`
- Finding files with a simple criterion:

```
$ find . -name manual.html
```

  Looks for files under the current directory whose name is *manual.html*
- The *criteria* always begin with a single hyphen, even though they have long names

3.20 `find` Criteria

- `find` accepts many different criteria; two of the most useful are:
  - `-name` *`pattern`*: selects files whose name matches the shell-style wildcard *pattern*
  - `-type d`, `-type f`: select directories or plain files, respectively
- You can have complex selections involving 'and', 'or', and 'not'

3.21 `find` Actions: Executing Programs

- `find` lets you specify an action for each file found; the default action is simply to print out the name
  - You can alternatively write that explicitly as `-print`
- Other actions include executing a program; for example, to delete all files whose name starts with *manual*:

```
find . -name 'manual*' -exec rm '{}' ';'
```

- The command `rm '{}'` is run for each file, with `'{}'` replaced by the filename
- The `{}` and `;` are required by `find`, but must be quoted to protect them from the shell

3.22 Exercises

1. **a.** Use the `df` command to display the amount of used and available space on your hard drive.
   b. Check the man page for `df`, and use it to find an option to the command which will display the free space in a more human-friendly form. Try both the single-letter and long-style options.
   c. Run the shell, `bash`, and see what happens. Remember that you were already running it to start with. Try leaving the shell you have started with the `exit` command.
2. **a.** Try `ls` with the `-a` and `-A` options. What is the difference between them?
   b. Write a `for` loop which goes through all the files in a directory and prints out their names with `echo`. If you write the whole thing on one line, then it will be easy to repeat it using the command line history.
   c. Change the loop so that it goes through the names of the people in the room (which needn't be the names of files) and print greetings to them.
   d. Of course, a simpler way to print a list of filenames is `echo *`. Why might this be useful, when we usually use the `ls` command?
3. **a.** Use the `find` command to list all the files and directories under your home directory. Try the `-type d` and `-type f` criteria to show just files and just directories.
   b. Use `locate` to find files whose name contains the string '`bashbug`'. Try the same search with `find`, looking over all files on the system. You'll need to use the `*` wildcard at the end of the pattern to match files with extensions.
   c. Find out what the `find` criterion `-iname` does.

