JUST ENOUGH UNIX

What is Unix

- Unix is an operating system (like Windows).
- That means it is a program that runs on a computer, and which makes it possible for you to use the computer (typically to run other programs).
- In some ways it is relatively old
  - The first Unix was written in the 1970s
  - It turns out that this is a strength :-)
- In some ways it is relatively new
  - There are new versions of Unix coming out all the time
- There are many flavors of Unix
  - OSX, Linux, SunOS and so on
  - There are many flavors of Linux also.

Unix is and isn't a WIMP

- You are most familiar with WIMP environments.
  - WIMP stands for "window, icon, menu, pointing device".
- While many Unix systems support this kind of interaction much Unix functionality doesn't need this.
- This is both a strength and a weakness.
- It also means that you need to learn to use the *command line*.

A little history

- Developed at AT&T Bell Laboratories in the 1970s.
- Released and distributed free of charge since AT&T was not allowed to compete in the computer industry at the time.
- Primarily created initially by Ken Thompson and Dennis Ritchie, coming after an interactive, multiuser operating system they had conceived earlier called *multics*—this became jokingly "unics" which evolved into UNIX and was released in 1971
- But early UNIX wasn't perfect, and so researchers at UCal Berkeley created a cleaner version, released in 1982 as "BSD" (Berkeley Software Distribution)

- Later, in 1991, Linus Torvalds (Finland), developed a version of UNIX for personal computers—Linux
- Today, there are basically four main versions of Unix:
  - System V UNIX (stems from original AT&T version)
  - BSD UNIX (Berkeley)
  - Linux
  - OS X (Mac)
- All now have decent windowing environments.

Features of UNIX

- "Open" software — *non-proprietary*, meaning that no single company or person owns it or is in charge of developing and/or maintaining it.
- *Multi-tasking* — meaning multiple programs can be running at one time, even on a single CPU system;
- This is called *timesharing* where the operating system provides small slices of time to multiple programs; switching between which one is actually running in any given millisecond is imperceptible to the user.
- Even a personal computer running UNIX has this ability.
- Typically this means that several people can use the same computer at the same time (though not the same keyboard and screen :-)

- Components:
  - *kernel* — resident in computer's main memory; primary resource manager; task/process manager.
  - *file system* — organizes files.
  - *shell* — interactive component that lets users enter *commands* on a "command-line" at a prompt (e.g., `unix>`).
  - *commands* — set of system utilities that come with the operating system which the user can invoke from the command-line.

Taking command

- Our use of Unix will be with the OSX operating system used by our cart Macs.
- OSX is a graphical environment built on top of a fairly standard Unix.
- The bit we'll make use of is the standard Unix.
- To use this, we will use the Terminal utility (which is an OSX version of the shell).
- When you run this, you get a window with something like:

```
student>
```

- This is the command line. A line on which you type commands.
- The bit of text on the command line before you type anything is called the *prompt*.

Making commands

- In Unix, the way you get the operating system to do things is to type instructions on the command line (and then hit "return").
- The things you type are the names of programs you want the system to run.
- For example typing:

```
date
```

  after the prompt (and hitting return) gives you the date.

- Similarly,

```
who
```

tells you who is using the computer (not so helpful on a single-user machine), and:

```
exit
```

or

```
logout
```

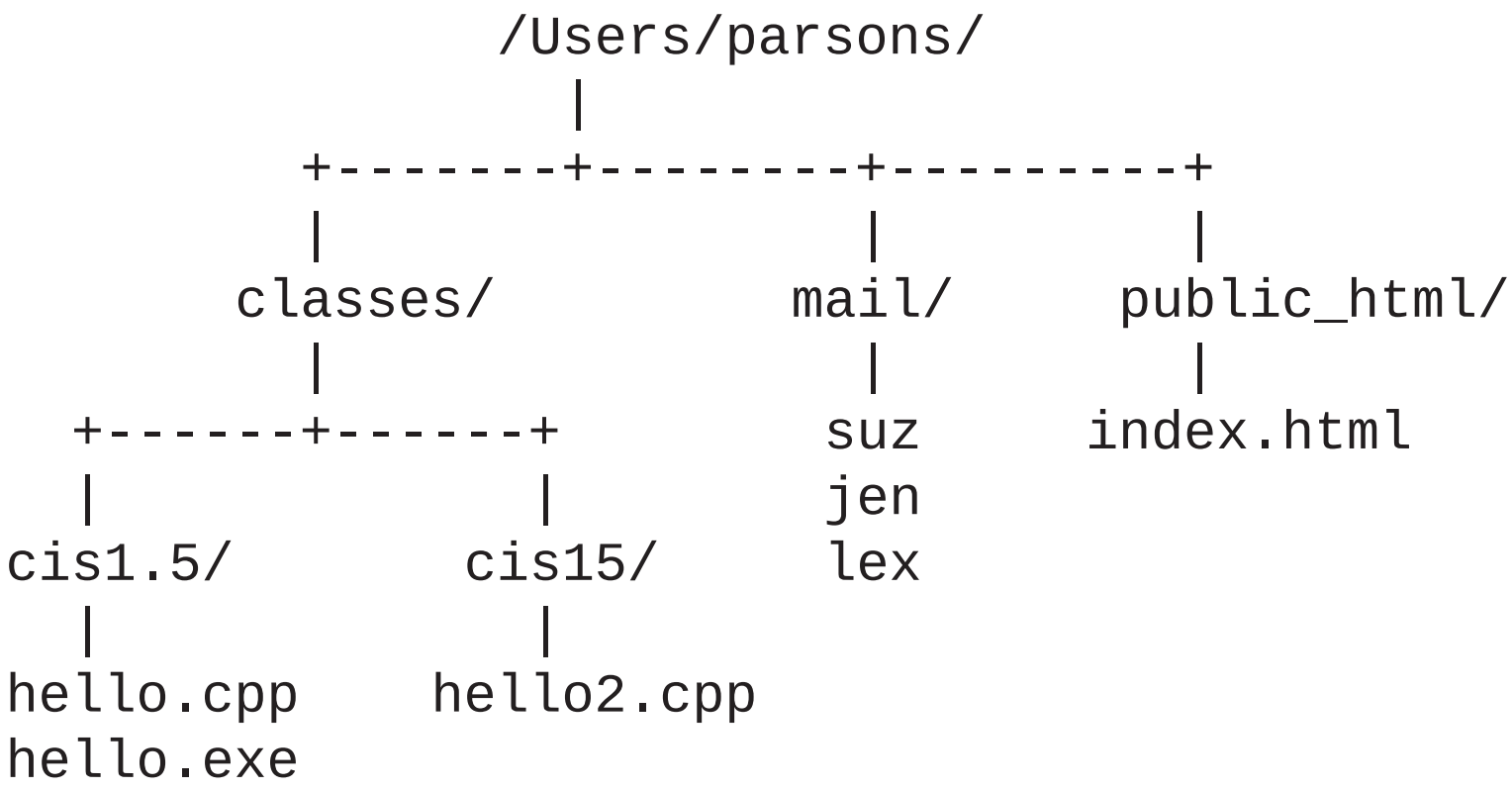
will stop the terminal window from running.

The Unix filesystem

- The Unix *filesystem* is the part of Unix that organizes and keeps track of data.
- You need to know a bit about how it works.
- As you already know, a *file* is a collection of related data.
- Unix has files like this ("ordinary" or "regular" files) and also has:
  - Device files (special files), which represent pieces of hardware like the screen, or a printer, or a USB memory key.
  - Directory files, which organise ordinary and device files.
- Directory files (or just "directories") are similar to the folders you are familiar with from Windows.

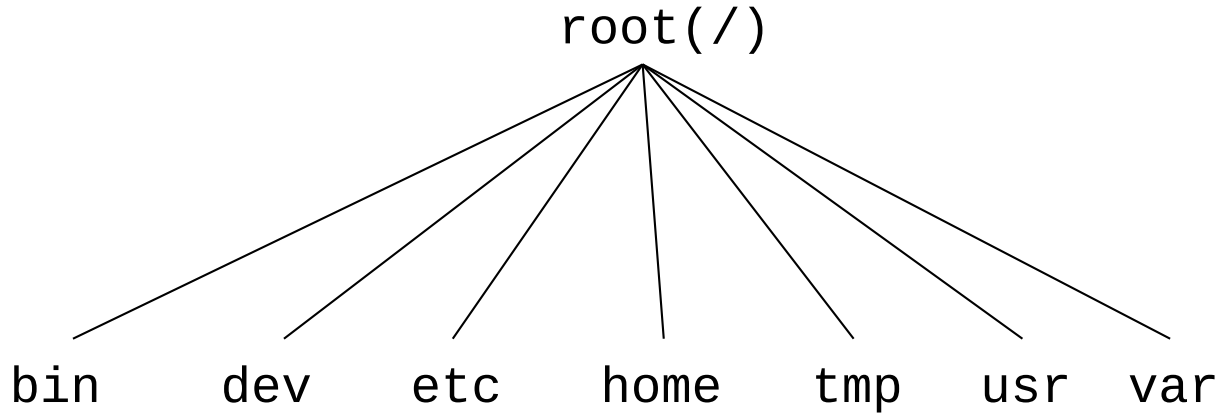
Directory tree example

- The file system is organised into trees (heirarchical):



File system structure

- A typical Unix filesystem is structured like this:



More structure

- `bin`: most of the commonly used Unix commands
- `dev`: device files
- `etc`: administrative files (including the password file)
- `home`: home directories (OSX uses Users)
- `tmp`: temporary files
- `usr`: a variety of stuff, depending on the version of Unix
- `var`: frequently varying data.

Location, location, location

- Every file has an *address*.
- That is its location in the filesystem.
- Unix calls this location its *path*
- For example, a file call `myprog.cpp` that is in my home directory will have an (asolute) path(name) of:

```
/Users/parsons/myprog.cpp
```

More location

- In a sense, the command line has a location as well.
- Each time you have a terminal window open, it is "looking at" a directory.
- You can find out which directory it is by typing:

```
pwd
```

- If I do this right after I open the terminal, I get:

```
/Users/parsons
```

Moving around

- We can move between directories
- If I'm in `/Users/parsons` and I type

```
ls
```

  I get a listing of that directory, something like:

```
admin       code    courses
myprog.cpp  papers
```

- To move to the directory `code`, I would then type:

```
cd code
```

- Both `ls` (list) and `cd` (change directory) are Unix commands.

More moving around

- If I'm in `/Users/parsons/code` and I want to move back to `Users/parsons`, I can type:

```
cd /Users/parsons
```

or

```
cd ../
```

- `../` is like saying "the parent of the current directory".
- Don't mistype. `./` means "this directory", so:

```
cd ./
```

has no effect (it changes to the current directory).

Moving things

- If I'm in `/Users/parsons` and I want to move `/Users/parsons/myprog.cpp` into `Users/parsons/code`, I can type:

```
mv myprog.cpp /Users/parsons/code
```

  or

```
mv myprog.cpp code
```

- Using:

```
mv myprog.cpp code/prog.cpp
```

  will not just move the file, but will also change its name.

- Using `cp` rather than `mv` will copy the file rather than move it.

Moving things again

- If I'm in `/Users/parsons/code` and I want to move `/Users/parsons/myprog.cpp` into `Users/parsons/code`, I can type:

```
mv /Users/parsons/myprog.cpp .
```

or

```
mv ../myprog.cpp .
```

- The `.` is also like saying "here".
- (In fact saying "." is exactly the same thing as saying "./").

Windows in UNIX

- Generic "windows" facilitate user access to multiple tasks ("processes") running at the same time
- *Window manager* controls "look & feel" of windows
- X Windows developed at MIT (Massachusetts Institute of Technology) for use with UNIX; still the most popular with all flavors of UNIX, even available for Macs

Basic Unix commands

- Some commands:
  - man
  - pwd
  - cd
  - ls
  - mkdir
  - rmdir
  - cp
  - mv
  - rm
  - chmod
- UNIX IS CASE-SENSITIVE!!!
- Commands have options or parameters or “switches”.
- *Switches* start with “–”

man

- get help (display manual page)
- **man** — display manual pages (get help!)
- **man man** — display manual page for the *man* command
- **man ls** — display manual page for the *ls* command
- **man -k file** — list all commands with the keyword *file*

- For example:

```
unix> man pwd
PWD(1)                          FSF                          PWD(1)

NAME
       pwd - print name of current/working directory

SYNOPSIS
       pwd [OPTION]

DESCRIPTION
       Print  the full filename of the current working directory.

       --help display this help and exit

       --version
              output version information and exit

       NOTE: your shell may have its own version of pwd, which
       usually supercedes the version descibed here.
...
```

pwd

- Print working directory

```
unix> pwd
/Users/parsons/teaching/cis15/notes
```

cd

- Change working directory

```
unix> pwd
/Users/parsons/
unix> cd classes
unix> pwd
/Users/parsons/classes
```

ls

- List the files in the current directory
- **ls -aF** — list all files and show their file types

```
unix> ls -aF
./
../
.bashrc
classes/
mail/
hello.cpp
```

- **ls -l** — list files in long format

```
unix> ls -l hello.cpp
-rw-r--r--    1 parsons  faculty   187 Sep 5 10:45 hello.cpp
```

mkdir

- Make (create) a directory

```
unix> ls -aF
./
../
.bashrc
classes/
mail/
hello.cpp
unix> mkdir junk
```

```
unix> ls -aF
./
../
.bashrc
classes/
junk/
mail/
hello.cpp
```

rmdir

- Remove (delete) a directory

```
unix> ls -aF
./
../
.bashrc
classes/
junk/
mail/
hello.cpp
unix> rmdir junk
```

```
unix> ls -aF
./
../
.bashrc
classes/
mail/
hello.cpp
```

cp

- Copy a file

```
unix> ls -aF
./
../
.bashrc
classes/
mail/
hello.cpp
unix> cp hello.cpp hi.cpp
```

```
unix> ls -aF
./
../
.bashrc
classes/
mail/
hello.cpp
hi.cpp
```

mv

- Move (rename) a file.

```
unix> ls -aF
./
../
.bashrc
classes/
mail/
hello.cpp
unix> mv hello.cpp howdy.cpp
```

```
unix> ls -aF
./
../
.bashrc
classes/
mail/
howdy.cpp
```

rm

- Remove (delete) a file

```
unix> ls -aF
./
../
.bashrc
classes/
mail/
hi.cpp
howdy.cpp
unix> rm hi.cpp
```

```
unix> ls -aF
./
../
.bashrc
classes/
mail/
howdy.cpp
```

chmod

- Change file mode
- 9 characters: `-uuugggooo`
- WHO: u = user, g = group, o = other users, a = all users (u + g + o)
- WHAT: r = read, w = write, x = execute
- MODE: + = allow, - = don't allow

```
unix> ls -l hi.cpp
-rwxr-xr-x    1 parsons  faculty   187 Sep 5 10:45 hi.cpp
unix> chmod a+w hi.cpp
unix> ls -l hi.cpp
-rwxrwxrwx    1 parsons  faculty   187 Sep 5 10:45 hi.cpp
```

Other UNIX commands

- **diff**: command used to compare the contents of two files
  ```
  unix> diff file1.txt file2.txt
  ```
- **more**: command used to list the contents of a file (only works well with plain text files!)
  ```
  unix> more file1.txt
  ```
- **wc**: command used to count (and display) the number of lines/words/characters in a file
  ```
  unix> wc file1.txt
  ```

Special characters: wild card matching

- You can use special characters on the unix command-line as "wild cards" in order to apply a command to a set of files that have similar characteristics
- The general wild card character is asterisk (`*`), which matches to anything (zero or one or more of any character)
- For example:

  `unix> ls *.txt`
  will list any files that end with `.txt`, such as `file1.txt` and `file2.txt`
  while
  `unix> ls A*`
  will list any files that start with `A`, such as `Abc.txt` and `A_to_Z`, but not `aA`

- Similarly
  `unix> ls A*Z`
  will list any files that start with `A` and end with `Z`, such as `AAAZ` and `A_to_Z`, but not `AAAZ.txt`

- Remember, file names and commands are *case sensitive!*
- A single character wild card is question mark (`?`), which matches to one character
- For example:
  `unix> ls A?.txt`
  will list files such as `AB.txt`, but not `A.txt` or `AAA.txt`
- We will do more with pattern matching and *regular expressions* later in the semester

Redirection

- You can "redirect" the output of a command or program to a file using the *redirection* symbol: `>`
- For example:
  `unix> wc file1.txt >file2.txt`
  will count the number of characters, words and lines in `file1.txt` and store the result in `file2.txt`. if you want to see the result, then you have to display `file2.txt`:
  `unix> more file2.txt`
- Redirection will create a new file (or first delete it if it exists) and then write the command/program output to the new file

- If you want to preserve the contents of the file to which the output is being redirected, you can *append* to the end of the file using >>
- For example:

```
unix> wc file1.txt >myfile.txt
unix> wc file2.txt >>myfile.txt
unix> more myfile.txt
```

If you can't remember all that

- Buy the T-shirt

Using C++ under Unix

- In CIS 1.5, you used an integrated development environment (IDE).
- Typically you used Dev C++ or CodeBlocks.
- The important operations that this IDE allowed you to carry out were:
  - Editing a C++ program.
  - Compiling a C++ program
  - Running a compiled program.
- You can carry out *exactly* the same steps under Unix.
- The way that you carry out the steps is different.

Editing a C++ program

- We edit our C++ programs using an *editor*.
- One tool we can use for this is Emacs
- According to the GNU project (who provide it):

  Emacs is the extensible, customizable, self-documenting real-time display editor

- Emacs is free software.

- `http://www.gnu.org/software/emacs/`

Free software

- Emacs is free in the sense that you have:
  - The freedom to run the program, for any purpose (freedom 0).
  - The freedom to study how the program works, and adapt it to your needs (freedom 1).
  - The freedom to redistribute copies so you can help your neighbor (freedom 2).
  - The freedom to improve the program, and release your improvements to the public, so that the whole community benefits (freedom 3).
- Access to the source code is a prerequisite for freedoms 1 and 3.

Other editors

- If you don't like Emacs, then there are a couple of other options.
- Nano is another free editor.
- Since we're using Macs for the lab exercises, you can also use Textedit.
- Textedit, though, isn't free. It's an Apple product.

Compiling a C++ program

- To compile our C++ programs, we will use another GNU product.
- This is `g++`, the GNU C++ compiler.
- We run the compiler (as we run any Unix command) by typing on the command line.
- To compile the program `myprog.cpp` we need to type:

```
g++ myprog.cpp
```

  at the prompt.
- If there are errors, `g++` will report them on the screen.
- If there are no errors, `g++` will run silently.

g++

- If we just type:

```
g++ myprog.cpp
```

  then g++ will create an output file called:

```
a.out
```

- If we want a more meaningful name, then we have to give one, like:

```
g++ myprog.cpp -o myprog.o
```

Running a C++ program

- Once your program has compiled successfully, you can run it.
- The compiled program, `myprog.o` is now something that can be run, just like any other Unix command.
- All you have to do, more or less, is to type its name:

```
./myprog.o
```

- Any output that `myprog` produces will be displayed on the screen

Summary

- This lecture introduced some of the basic ideas that you will need to know about the Unix operating system.
- We concentrated on the things that you will need to know in order to:
  - Edit;
  - Compile; and
  - Run C++ programs

  under the Unix operating system.