Files and Directories

Files and Directories (1)

- What is a file?
  - a container for data
  - persistent (stays around) and accessible by name
- Unix files
  - Unix file types: regular, directory, device, link and etc.
  - Unix files are identified by a name in a directory
    - this name is actually used to resolve the hard disk name/number, the cylinder number, the track number, the sector, the block number
      - you see none of this
    - it allows the file to be accessed

Files and Directories (2)

- Regular file
  - essentially a sequence of bytes
  - can access these bytes in order
  - Text file: contains only printable characters and Line Feed (“LF”) or *newline* character
  - Binary file: contains characters of entire ASCII range from 0 to 255
- Directory file
  - a file containing name and pointer (inode number) pairs for files and subdirectories in the directory
  - equivalent of a “folder” in Windows

Files and Directories (3)

- Device file
  - access a device (like a soundcard, mouse, terminal, or ...) like it is a file
- Links
  - hard link: create another name for a file
  - soft link: a pointer to another file
    - used like the file it points to
    - similar to “shortcuts” in Windows
- FIFO and etc.

Files and Directories (4)

- To get file type information
  - Use –F option for ls

```
compute[1] > ls –F
tmp/      a.out*      smit.script      cs211@
```

  - Use ls --color=auto

    different file type with different color
  - Use ls –l

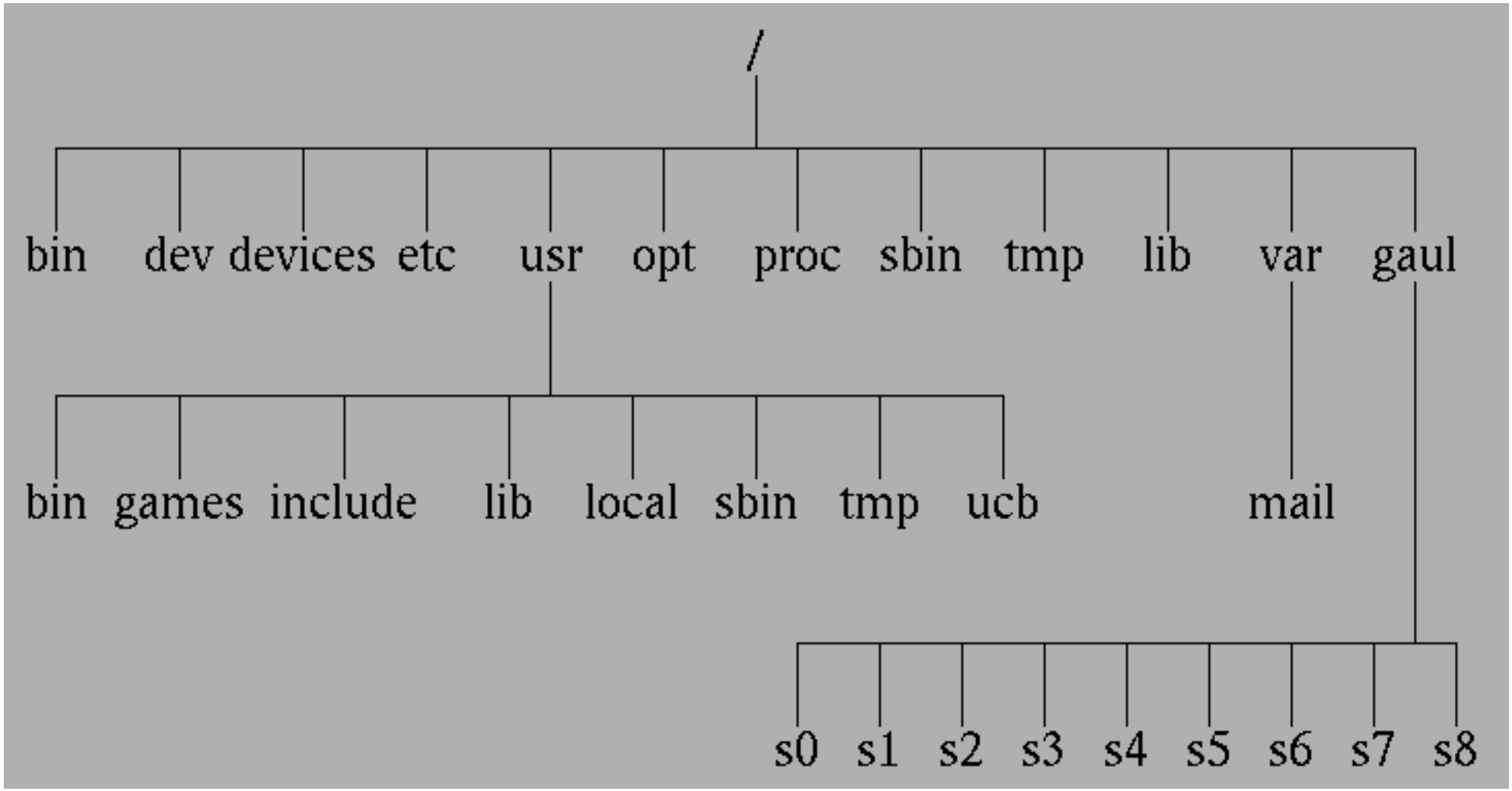
    first letter of the long listing format indicates file type

Unix File System (1)

- The upside-down tree
  - the Unix file system is organized like an upside-down tree
    - at the top of the file system is the root
      - write this as a lone slash: **/**
      - this is NOT a backslash (opposite of MS-DOS)!
    - For example, you can change to the root directory:

```
compute[1] > cd /
compute[2] > ls
TT_DB/      dev/       home/       mnt/        sbin/      xfn/
bin@        devices/   kernel/     net/        tmp/
boot/       etc/       lib@        opt/        usr/
core        export/    lib64@      platform/   var/
courses@    gaull/     lost+found/ proc/       vol/
```

Unix File System (2)



Unix File System (3)

- Some standard directories and files in a typical Unix system
  - / the root
  - /bin BINaries executables, i.e. commands
  - /dev DEVices (peripherals)
  - /sys/devices where the DEVICES really live
  - /etc startup and control files
  - /lib LIBraries
  - /opt OPTional software packages
  - /proc access to PROCesses
  - /sbin Standalone BINaries
  - /tmp place for TeMPorary files
  - /usr USeR stuff

Unix File System (4)

- /usr/bin BINaries (commands) again
- /usr/include include files for compilers
- /usr/lib LIBraries of functions etc.
- /usr/local local stuff
- /usr/local/bin local BINaries
- /usr/local/lib local LIBraries
- /usr/sbin sys admin stuff
- /usr/tmp place for more TeMPorary files
- /usr/ucb UCB binaries
- /var VARiable stuff
- /var/mail the mail spool

Unix File System (5)

- A typical Unix file system spans many disks
  - As a user you don't know or need to know which physical disk things are on
    - in fact, you don't even know which machine they are attached to: disks can be "remote" (e.g.: your home directory is stored on a disk attached to a server in the machine room.
  - Part of the file system may come from another system with network file system
    - Look at the *df* command to see different disks or different filesystems and space used.
  - You just need to know the tree structure of the file system

Pathnames (1)

- In Unix file system, inside each directory there may be more directories

- The Absolute Path
  - to identify where a file is, concatenate the directories together
    - separating names with slashes:
    - e.g. /home/kzhang
    - This is the absolute path for my home directory
    - lists everything from the root down to the directory you want to specify

Pathnames (2)

- When you first log in, you are in your HOME directory
  - To see what this is:

    compute[1] > pwd

    /home/kzhang
  - Your home directory is also stored in the environment variable HOME

    compute[2] > echo My home is $HOME

    My home is /home/kzhang
  - You can “Go Home” by typing

    compute[3] > cd $HOME

Pathnames (3)

- Some shorthand
  - In some shells (including bash, tcsh, and csh), $HOME can be abbreviated as ~ (tilde)
  - Example: compute[4] > cd ~/bin
    - change to the bin directory under your home directory (equivalent to $HOME/bin)
    - this is where you usually store your own commands or “executables”
  - To quickly go home:

    compute[5] > cd ~ or just cd

    with no parameters, cd changes to your home directory
  - ~user refers to the home directory of user
    - For me, ~kzhang is the same as ~
    - ~doug refers to Doug Vancise’s home directory (/home/doug)

Pathnames (4)

- Relative pathnames
  - You can also specify pathnames relative to the current working directory
    - This is called a relative pathname
  - For example

```
compute[6] > pwd
 /home/kzhang
compute[7] > ls
 tmp/      a.out*      smit.script    cs211@
compute[8] > cd tmp
compute[9] > pwd
 /home/kzhang/tmp
```

    - Note: You don't need to know absolute pathnames
- For most commands which require a file name, you can specify a pathname (relative or absolute)

Pathnames (5)

- Every directory contains two "special" directories: . and .. Use ls –a to see them
  - . : another name for the current directory
    - e.g. cp cs2211/foo .
  - .. : another name for the immediate parent directory of the current directory
    - use this to cd to your parent:

```
compute[10] > pwd
 /home/kzhang/cs2211
compute[11] > cd ..
compute[12] > pwd
 /home/kzhang
compute[13] > cd ../..
compute[14] > pwd
 /
```

Pathnames (6)

- You can locate a file or directory by this way:
  - look at the first character of the pathname
    - / start from the root
    - ~ start from a home directory
    - . start from the current directory
    - .. start from the parent directory
    - else start from the current directory
  - going down to the subdirectories in the pathname, until you complete the whole pathname.
  - if you start in ~kzhang, the following are equivalent:
    - /home/kzhang/cs2211/readme.txt
    - ~/cs2211/readme.txt
    - cs2211/readme.txt

Working with Directories (1)

- Home Directory
  - When a user log in, the login directory is the user's home directory
- Current Working Directory
  - the directory you are looking at right now
  - the shell remembers this for you
- To determine the Current Working Directory, use the command pwd (Print Working Directory)
  - use: compute[1] > pwd
  - result: print the current working directory

Working with Directories (2)

- Create a directory with the mkdir command

  mkdir newdirname

- newdirname can be given with pathname

```
compute[2] > pwd
/home/kzhang/cs2211
compute[3] > ls
readme.txt
compute[4] > mkdir mydir1; ls
readme.txt   mydir1/
compute[5] > mkdir mydir1/mydir2
compute[6] > ls mydir1
mydir2/
compute[7] > cd mydir1/mydir2
```

Note: two commands in the same line

Note: we can specify a directory with ls

Working with Directories (3)

- Remove a directory with the rmdir command

  rmdir dirname

  – dirname is the directory to remove and can be specified using a pathname

  – if the directory exists and is **empty** it will be removed

- Examples:

```
compute[8] > cd ~/cs2211; ls
readme.txt  mydir1/
compute[9] > ls mydir1
mydir2/
compute[10] > rmdir mydir1/mydir2
compute[11] > ls mydir1
compute[12] > rmdir mydir1
```

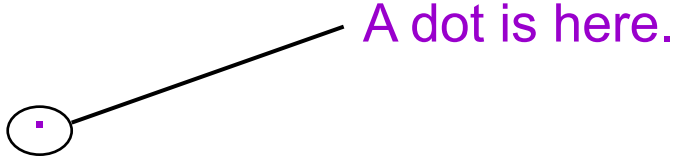
Assuming mydir1/mydir2 is still empty

mydir1 is now empty, so this will work fine

Working with Directories (4)

- Move a file from one directory to another

```
compute[13] >  pwd; ls; ls mydir1
/home/kzhang/cs2211
mydir1/  readme.txt
hello.txt
compute[14] >  mv mydir1/hello.txt .
compute[15] >  ls mydir1
compute[16] >  ls
hello.txt  mydir1/  readme.txt
```



- Rename with mv

```
compute[17] > mv hello.txt  world.txt
```

- You can also move a directory the same way - it is just a special file, after all.

Working with Directories (5)

- Copy a file from one directory to another

```
compute[18] > ls
readme.txt  mydir1/
compute[19] > cp readme.txt mydir1
compute[20] > ls mydir1
readme.txt
```

- Copying a directory

```
compute[21] > cp mydir1 mydir2
cp: mydir1: is a directory
compute[22] > cp –r mydir1 mydir2
compute[23] > ls mydir2
readme.txt
```

Cannot use just cp to copy a directory

Must do a recursive copy (cp –r) to copy a directory

- What if mydir2 already exist?

Working with Directories (6)

- Some shells (bash, csh and tcsh) provide pushd and popd directory commands
- pushd changes directories, but remembers the previous one by pushing it on to a stack
- popd changes directories back to the last directory placed on the stack by pushd

```
compute[24] > pwd
/home/kzhang
compute[25] > pushd cs2211
~/cs2211 ~
compute[26] > pwd
/home/kzhang/cs2211
compute[27] > popd
~
compute[28] > pwd
/home/kzhang
```

Current directory stack: ~ was where we were

Current directory

Current directory stack: now empty

Hard and Symbolic Links (1)

- When a file is created, there is one link to it.
- Additional links can be added to a file using the command ln. These are called hard links.
- Each hard link acts like a pointer to the file and are indistinguishable from the original.

```
compute[1] > ls
readme.txt
compute[2] > ln readme.txt unix_is_easy
compute[3] > ls
readme.txt   unix_is_easy
```

- There is only one copy of the file contents on the hard disk, but now two distinct names!

Hard and Symbolic Links (2)

- A symbolic link is an indirect pointer to another file or directory.
- It is a directory entry containing the pathname of the pointed file.

```
compute[1] > cd
compute[2] > ln –s  /usr/local/bin  bin
compute[3] > ls –l
lrwxrwxrwx  bin –> /usr/local/bin
……
compute[4] > cd –P bin
compute[5] > pwd
/usr/local/bin
```

Hard and Symbolic Links (3)

- Two hard links have the same authority to a file
  - Removing any of them will NOT remove the contents of the file
  - Removing all of the hard links will remove the contents of the file from the hard disk.
- A symbolic link is just an entry to the real name
  - Removing the symbolic link does not affect the file
  - Removing the original name will remove the contents of the file
- Only super users can create hard links for directories
- Hard links must point to files in the same Unix filesystem

Finding Files (1)

- What if you need to locate a file, or set of files, in a large directory structure?
  - Using cd and ls would be very tedious!
- The command find is used to search through directories to locate files.
  - Wildcards can be used, if the exact file name is unknown, or to find multiple files at once.
  - Can also find files based on size, owner, creation time, type, permissions, and so on.
  - Can also automatically execute commands on each file found.
- Do a "man find" for details and examples!

Finding Files (2)

- Use the find command
  - Recursively searches, starting from a given directory, for files and/or directories matching a given expression
- Usage: find PATH EXPRESSION.
  - e.g. Find all files and directories named README starting from the current directory:

current directory

```
find . –name “README”
```

  - e.g. Find all files and directories with the extension .h starting from /usr/include:

```
find /usr/include –name “*.h”
```

* is called a wildcard

万能牌 hhh.

Finding Files (3)

- Usage: find PATH EXPRESSION.
  - e.g. Find all regular files (but not directories) named backup starting from the current directory:

    find . –type f –name “backup”
  - e.g. Find all C programs of my account:

    find ~ –type f –name “*.c”
  - e.g. Find all directories (but not other files) named backup starting from the current directory:

    find . –type d –name “backup”

More Files and Directories (1)

- What files do I already have in my home directory?
  - May have startup files for bash (.bash_profile, .bashrc)
  - Contain commands run after you type your password, but before you get a prompt
  - Assume you've not used your account before

    compute[1] > ls

    compute[2] >
  - Why can't I see any files?
    - Files beginning with a 'dot' are usually control files in Unix and not generally displayed
  - Use the –a option to see all files

    compute[2] > ls –a

    ./ ../ .bash_history .bash_profile .bashrc … .viminfo
  - May have startup files for csh and tcsh (.login, .cshrc)

More Files and Directories (2)

- OK, let us study some new commands, and variations of some familiar ones

```
compute[3] > ls  –a
./  ../  .bash_history .bash_profile .bashrc  …
compute[4] > cp .bashrc my_new_file
compute[5] > ls  –a
./   ../   .bash_history .bash_profile .bashrc   …   my_new_file
compute[6] > cp  –i .bash_profile my_new_file
cp: overwrite my_new_file (yes/no)? y
compute[7] > tail  –7  my_new_file

export PS1="\h:\w[\!] > "

# get aliases and functions
if [ –f  ~/.bashrc ]; then
  .  ~/.bashrc
fi
```

list all files including those beginning with a .

The –i option says to ask when this overwrites existing files.

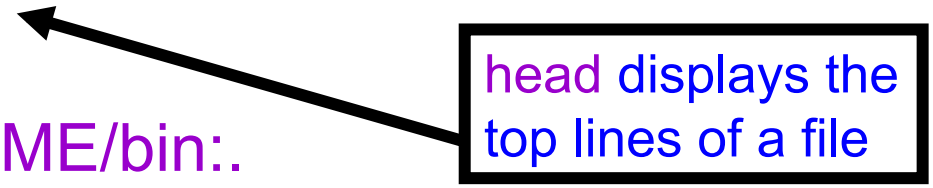
tail displays the bottom lines of a file

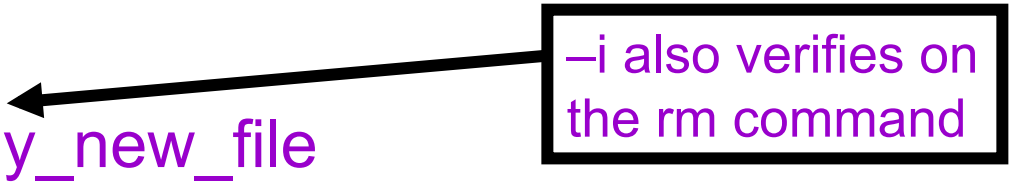
More Files and Directories (3)

```
compute[8] > head –6 my_new_file
# set PATH and/or TERM
export PATH=$PATH:$HOME/bin:.

# set umask
umask 077

compute[9] > rm –i my_new_file
rm: remove my_new_file (yes/no)? y
```





You may want to put

```
alias rm='rm –i'
```

in your .bashrc file

More Files and Directories (4)

- Pager
  - A command that displays one screen of text at a time
  - Waits for user to press a key and then displays the next screen
- more
  - Can only move forward.
  - Press the **Spacebar** to move to next screen.
  - Press **q** at any time to quit.
  - e.g. Display **README.txt**: **more README.txt**

More Files and Directories (5)

- less
  - Can move forward and backward
  - Use arrow keys to move up and down one line at a time
  - Press the **Spacebar** to move to next screen
  - Press **Ctrl+b** to move back one screen
  - Press **q** at any time to quit
  - e.g. Display **README.txt**: **less README.txt**

Unix File Names (1)

- Almost any character is valid in a file name
  - all the punctuation and digits
  - the exception is the / (slash) character and null character
  - usually letters, digits, and . – _
  - the following are not encouraged
    - ? * [ ] “ ” ’ ( ) & : ; !
  - the following are not encouraged as the first character
    - – ~
  - control characters are also allowed, but are not encouraged

Unix File Names (2)

- Upper and lower case letters are different
  - A.txt and a.txt are different files
- No enforced extensions
  - The following are all legal Unix file names
    - a
    - a.
    - .a hidden and not covraged.
    - …
    - a.b.c
- Remember files beginning with dot are hidden
  - ls cannot see them, use ls –a

Unix File Names (3)

- Even though Unix doesn't enforce extensions,
  - “.” and an extension are still used for clarity
    - .jpg for JPEG images
    - .tex for LaTeX files
    - .sh for shell scripts
    - .txt for text files
    - .mp4 for MP4’s
  - some applications may enforce their own extensions
    - Compilers look for these extensions by default
      - .c means a C program file
      - .C or .cpp or .cc for C++ program files
      - .h for C or C++ header files
      - .o means an object file

Unix File Names (4)

- Executable files usually have no extensions
  - cannot execute file a.exe by just typing a
  - telling executable files from data files can be difficult
- "file" command

  Use: file filename

  Result: print the type of the file

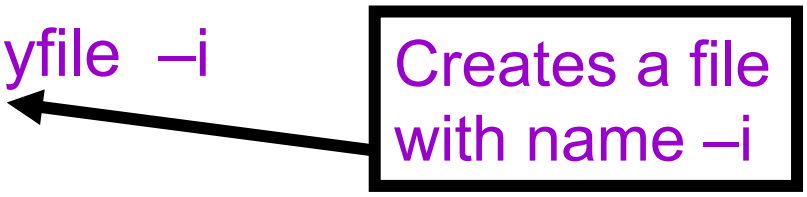
  Example: compute[1] > file .bashrc
  .bashrc: ASCII text

- Filenames and pathnames have limits on lengths
  - 255 for file name and 4096 for path typically
  - these are pretty long (much better than MS-DOS days and the 8.3 filenames)

Fixing Filename Mistakes

- It is very easy to get the wrong stuff into filenames
  - Say you accidentally typed

    compute[2] > cp -- myfile –i

  - What if you type

    compute[3] > rm –i
    - The shell thinks -i is an option, not a file
    - Getting rid of these files can be painful

- There is an easy way to fix this...
  - You simply type

    compute[4] > rm -- –i
  - Many commands use "--" to say there are no more options

Filename Wildcarding (1)

- Wildcarding is the use of “special” characters to represent or match a sequence of other characters
  - a short sequence of characters can match a long one
  - a sequence may also match a large number of sequences
- Often use wildcard characters to match file names
  - Filename expansion – generally known as “globbing”
- Filename expansion wildcard characters

  ***** matches a sequence of zero or more characters
    - Example: a*.c* matches abc.c, abra.cpp,

  ? matches any single character
    - Example: a?.c matches ab.c, ax.c, but not abc.c

  [...] matches any one character between the braces
    - Example: b[aei]t matches bat, bet, or bit, not baet

Filename Wildcarding (2)

- Wildcard sequences can be combined

  compute[1] > mv a*.[ch] cfiles/

  - mv all files beginning with a and ending with .c or .h into the directory cfiles

  compute[2] > ls [abc]*.?

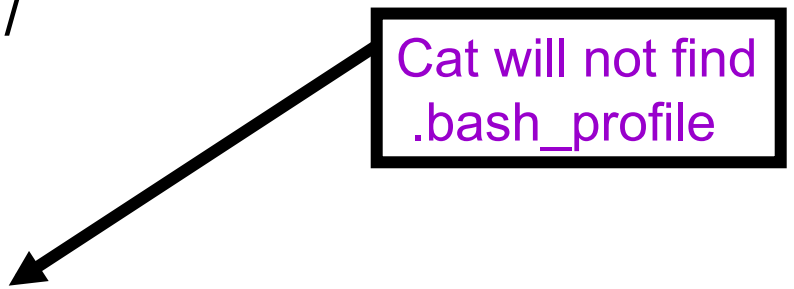
  - list files whose name begins with a, b, or c and ends with **.** (dot) followed by a single character
- Wildcards do not cross "/" boundaries
  - Example: csnow*c does not match csnow/codec
  - Filename expansion will only do expansion in one directory
- Wildcards are expanded by the shell, and not by commands
  - Programmers of commands do not worry about searching the directory tree for matching file names
  - The program just sees the list of files matched

Filename Wildcarding (3)

- Matching the dot
  - A dot (**.**) at
    - the beginning of a filename, or
    - immediately following a /

    must be matched explicitly.
  - Similar to the character */*
  - Example:

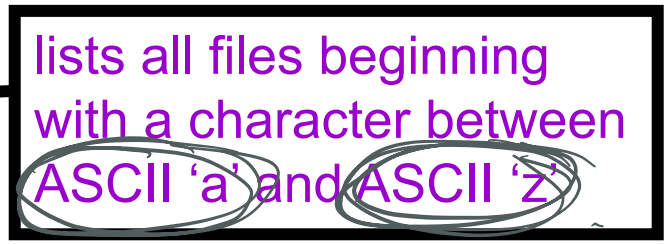
    compute[3] > cat *profile



- As mentioned earlier, [....] matches any one of the characters enclosed
  - Within "[...]", a pair of characters separated by "-" matches any character lexically between the two
    - Example:

      compute[4] > ls [a-z]*

      (may or may not work for default bash)



Filename Wildcarding (4)

- More advanced examples:
  - What does the following do?

    compute[5] > ls /bin/*[–_]*
  - What about this?

    compute[6] > ls * all files.
  - What about this?

    compute[7] > mv *.bat *.bit file type changed.

    Answer: this one is complicated…

Unix Quoting (1)

- Double Quotes: "...."
  - Putting text in double quotes "..." stops interpretation of some shell special characters (whitespace mostly, *, ~)
  - Examples:

```
compute[1] > echo  Here    are       some       words
Here are some words
compute[2] > echo "Here    are       some       words"
Here    are       some       words
compute[3] > mkdir "A directory name with spaces! "
compute[4] > echo "Welcome $HOME"
Welcome /home/kzhang
```

Unix Quoting (2)

- Single Quotes '...'
  - Stops interpretation of even more specials
    - stop variable expansion ($HOME, etc.)

```
compute[5] > echo 'Welcome $HOME'
Welcome $HOME
```

- Back Quotes `...`
  - execute a command and return result

```
compute[6] > echo `ls  –d c*`
cs2211
```

- Note difference: single quote ('), back quote (`)

Unix Quoting (3)

- Backslash \
  - 'quotes' the next character
  - Lets one escape all of the shell special characters

```
compute[7] > mkdir Dir\ name\ with\ spaces\*\*
compute[8] > ls Dir\ *
Dir name with spaces**/
```

  - Use backslash to escape other shell special characters
    - Like quote characters

```
compute[9] > echo \"Bartlett\'s Familiar Quotations\"
"Bartlett's Familiar Quotations"
```

  - Use backslash to escape a newline character

```
compute[10] > echo "This is a long line and\
> we want to continue on the next"
This is a long line and we want to continue on the next
```

Unix Quoting (4)

- Control-V
  - Quotes the next character, even if it is a control character
  - Lets one get weird stuff into the command line
  - Very similar to backslash but generally for ASCII characters which do not show up on the screen
  - Example: the backspace character

```
compute[11] > echo "abc^H^H^Hcde"
cde
```

Control-h is backspace on most terminals

typing Control-v Control-h enters a "quoted" Control-h to the shell
- written ^H

  - Precisely how it works is dependent on the shell you use, and the type of terminal you are using

SFTP (1)

- SFTP Secure File Transfer Protocol

```
compute[1] > sftp kzhang@compute.csd.uwo.ca
Password:
Connected to compute.csd.uwo.ca.
sftp> get remotefile localfile
……
sftp> quit
```

What if I do the following?

```
compute[2] > ssh kzhang@compute.gaul.csd.uwo.ca
……
compute[2] > sftp kzhang@compute.gaul.csd.uwo.ca
```

SFTP (2)

- Basic SFTP commands
  - ls list the remote directory (lls for local directory)
  - pwd show path of the remote directory (lpwd)
  - cd change the remote directory (lcd)
  - get remotefile [localfile] download remotefile
  - put localfile [remotefile] upload localfile
  - get file_name_with_wildcards get multiple files
  - put file_name_with_wildcards put multiple files
  - bye quit
  - quit quit
  - ? list all the available commands