CSE 391
Lecture 5

bash shell continued:
I/O redirection, streams, xargs, processes

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Lecture summary

- A bit more on combining commands
- Processes and basic process management

File examination

command	description
`cat`	output a file's contents on the console
`more or less`	output a file's contents, one page at a time
`head, tail`	output the first or last few lines of a file
`wc`	count words, characters, and lines in a file
`du`	report disk space used by a file(s)
`diff`	compare two files and report differences

- Let's explore what we can do here...

Searching and sorting

command	description
`grep`	search a file for a given string (useful options: –v and –i)
`sort`	convert an input into a sorted output by lines
`uniq`	strip duplicate (adjacent) lines
`find`	search for files within a given directory
`locate`	search for files on the entire system
`which`	shows the complete path of a command
`cut`	extract a column of text from a file

- `grep` is actually a very powerful search tool; more later…

- *Exercise* : Display the contents of the text file `names.txt` in alphabetical order.

Review: Redirection and Pipes

- ***command*** > ***filename***
  - Write the output of ***command*** to ***filename*** (>> to append instead)
- ***command*** < ***filename***
  - Use ***filename*** as the input stream to ***command***
- ***command1*** | ***command2***
  - Use the console output of ***command1*** as the input to ***command2***
- ***command1*** ; ***command2***
  - Run ***command1*** and then run ***command2***
- ***command1*** && ***command2***
  - Run ***command1***, if completed without errors then run ***command2***

Streams in the Shell

- Stdin, stdout, stderr
  - These default to the console
  - Some commands that expect an input stream will thus read from the console if you don't tell it otherwise.
- *Example:* grep hi
  - What happens? Why?

We can change the default streams to something other than the console via redirection.

Output redirection

command `>` ***filename***

- run ***command*** and write its output to ***filename*** instead of to console;
  - think of it like an arrow going from the command to the file...
  - if the file already exists, it will be overwritten (be careful)
- `>>` appends rather than overwriting, if the file already exists
- ***`command`*** `> /dev/null` suppresses the output of the command

- Example: `ls -l > myfiles.txt`
- Example: `java Foo >> Foo_output.txt`
- Example: `cat > somefile.txt` (writes console input to the file until you press `^D`)

- *Exercise* : List the vegetables in `veggies.txt` in alphabetical order in the file `sortedVeggies.txt`.

Input redirection

command `<` ***filename***

- run ***command*** and read its input from ***filename*** instead of console
  - whenever the program prompts the user to enter input (such as reading from a `Scanner` in Java), it will instead read the input from a file
  - some commands don't use this; they accept a file name as an argument
- again note that this affects *user input*, not *parameters*
- useful with commands that can process standard input or files:
  - e.g. `grep`, `more`, `head`, `tail`, `wc`, `sort`, `uniq`, `write`

- Example: `java Guess < input.txt`

- *Exercise* : run `HelloWorld` taking input from `names.txt`
- *Exercise* : run it again and write the output to `output.txt`

Tricky Examples

- Amongst the top 250 movies in movies.txt, display the third to last movie that contains "The" in the title when movie titles are sorted.

- The wc command can take multiple files: wc names.txt student.txt
  - Can we use the following to wc on every txt file in the directory?
    - `ls *.txt | wc`

- Find the disk space usage of the man program
  - Hints: use `which` and `du`...
  - Does `which man | du` work?

Answers posted in lecture_commands.txt after lecture

Command Substitution

command1 `$(`***command2***`)`

- run ***command2*** and pass its console output to ***command1*** as a parameter;
- best used when ***command2***'s output is short (one line)

- Finish the example!
  - `du $(which man)`

xargs

command	description
`xargs`	run each line of input as an argument to a specified command

- `xargs` allows you to repeatedly run a command over a set of lines
  - often used in conjunction with `find` to process each of a set of files

- Example: Remove all my .class files from my home directory (and its subdirectories).

```
find ~ -name "*.class" | xargs rm
```

- Find the disk usage of `man` using `xargs`
  - `which man | xargs du`

tee

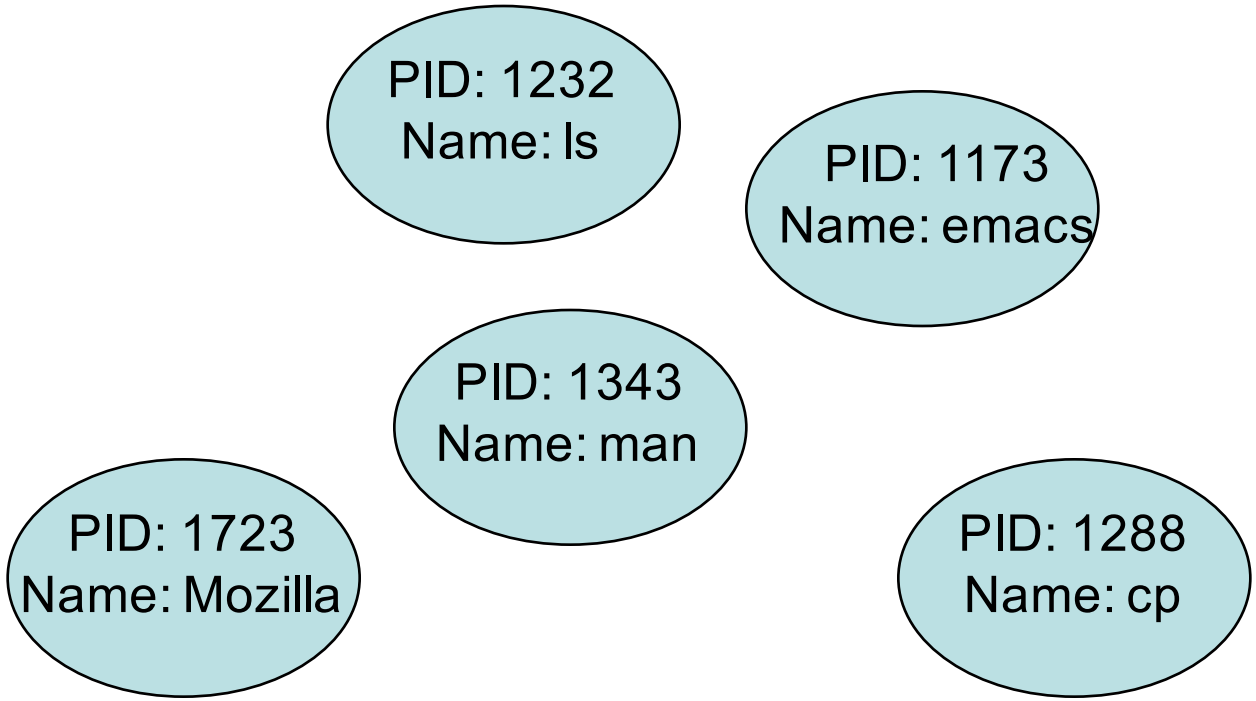
command	description
`tee`	copies standard input to standard output (similar to cat) and also outputs to one or more files

- Example: Run the HelloWorld java program, and produce output to the console as well as to a file.

```
Java HelloWorld | tee output.txt
```

Processes

- **process**: a program that is running (essentially)
  - when you run commands in a shell, it launches a process for each command
  - Process management is one of the major purposes of an OS



Process commands

command	description
`ps or jobs`	list processes being run by a user; each process has a unique integer id (PID)
`top`	show which processes are using CPU/memory; also shows stats about the computer
`kill`	terminate a process by PID (sometimes –KILL is needed)
`killall`	terminate several processes by name

- use `kill` or `killall` to stop a runaway process (infinite loop)
  - similar to ^C hotkey, but doesn't require keyboard intervention

Background processes

command	description
`&`	(special character) when placed at the end of a command, runs that command in the background
`^Z`	(hotkey) suspends the currently running process
`fg`, `bg`	resumes the currently suspended process in either the foreground or background

- On the VM, if you run a graphical program like `gedit` or `emacs` from the shell, the shell will lock up waiting for the graphical program to finish
  - instead, run the program in the background, so the shell won't wait:

    ```
    $ emacs homework1.txt &
    ```

  - if you forget to use `&` , suspend emacs by hitting `^Z` at the TERMINAL (NOT in emacs), then run bg from the terminal
  - lets play around with an infinite process…

screen

command	description
screen	A program that allows you to run multiple shells at once

- Create a new screen session
  - screen
- Creates a new screen session with the given name
  - screen –S session_name
- Reattach to a session
  - screen –r [optional-screen-id]

- Detach from a screen session with Ctrl+a d

screen

- When you create a new screen, it will open a new window with a new shell that looks very similar like the window you just came from.
- Ctrl+a ? will list commands that may be used within a screen
- Using screen is similar to having processes run in the background. When you are in a screen session, if you run a command, you can detach from the screen session, returning to your original window and your command will continue to run.
- If you create a screen session on attu then log off attu, your screen session will still be there when you return

Connecting with ssh

command	description
ssh	open a shell on a remote server

- Linux/Unix are built to be used in multi-user environments where several users are logged in to the same machine at the same time
  - users can be logged in either locally or via the network
- You can connect to other Linux/Unix servers with ssh
  - once connected, you can run commands on the remote server
  - other users might also be connected; you can interact with them
  - can connect even from other operating systems

The CSE attu server

- `attu` : The UW CSE department's shared Linux server
  (only available to CSE majors)
- Connect to `attu` by typing:

```
ssh attu.cs.washington.edu
```

(or `ssh username@attu.cs.washington.edu` if your Linux system's user name is different than your CSE user name)

Students with EE accounts may use their departmental servers

All UW students may use UW Linux servers. (how to activate your account)

- Note: There are several computers that respond as attu (to spread load), so if you want to be on the same machine as your friend, you may need to connect to attu2, attu3, etc.

Multi-user environments

command	description
`whoami`	outputs your username
`passwd`	changes your password
`hostname`	outputs this computer's name/address
`w or finger`	see info about people logged in to this server
`write`	send a message to another logged in user

- *Exercise* : Connect to `attu`, and send somebody else a message.

Network commands

command	description
`links or lynx`	text-only web browsers (really!)
`ssh`	connect to a remote server
`sftp or scp`	transfer files to/from a remote server (after starting sftp, use get and put commands)
`wget`	download from a URL to a file
`curl`	download from a URL and output to console
`alpine, mail`	text-only email programs

Mounting remote files

command	description
`sshfs`	mount and interact with remote directories and files

- An alternate usage model to remotely connecting to servers is mounting remote directories and files and work on them locally
  - once mounted, use remote directories and files as if they were local

Mounting cse homedir on VM

For CSE majors: you can access your home dir on attu from the VM as follows:

- Create a directory on the VM in your home directory, called csehomedir:
  - cd
  - mkdir csehomedir
- Now to use that directory as a "link" to your CSE files on your VM:
  - sshfs username@attu: ~/csehomedir **OR**
  - sshfs username@attu.cs.washington.edu:/homes/iws/username ~/csehomedir/
- It is a good idea to back up your files from your VM regularly.
  - Actually keep your files on your CSE home directory
  - Regularly move files from your VM to another location
  - If you need to get a fresh VM image, you can save the files from your old VM using this procedure: **"My VM Seems Broken. How Do I Recover?"**

My VM is Broken!

- If your VM is misbehaving, first try a reboot of the VM and also of your machine. If that doesn't work, often it is easiest just to get a fresh VM image and start over (maybe you saved the .zip file you downloaded previously?)
- BEFORE you delete your current copy of the VM, you can save the files from your current copy of the VM using this procedure:
  - See **"Recovering A Broken VM"** here:
  - **https://https://www.cs.washington.edu/lab/software/linuxhomevm**