

# **Introduction to Linux, Commands, Hands On**

Spring 2017

Victor Eijkhout and Charlie Dey

# How to Get Help

## Before we go further...

- Read the Manual.
  - `man command`
  - `man [section] command`
  - `man -k keyword` (search all manuals based on keyword)
- Most commands have a built-in UNIX manual, even the **man** command!
- Commands without manuals have help too, with **-h**, **--help**, or **/?** option.

# How to Get Help

## The Manual

- The manual pages are divided into eight sections depending on type of command.
  - 1 commands and applications
  - 2 system calls
  - 3 C library functions
  - 4 special files
  - 5 file formats
  - 6 games
  - 7 misc.
  - 8 system administration utilities

# Conventions for this lecture

- Commands will be in bold, options will be in italics.  
`command` *–arguments*
- In helpfiles and manuals, commands will have required input and option input
- **cp** [*OPTION*] *source destination*
  - Optional arguments are in brackets, required arguments are not.
- **cp** *–R* or **cp** *- -recursive*
  - Short options ‘-’, long options ‘- -’

# Linux Accounts

- To access a Linux system you need to have an *account*
- Linux account includes:
  - username and password
  - userid and groupid
  - home directory
    - a place to keep all your snazzy files
    - may be quota'd, meaning that the system imposes a limit on how much data you can have
  - a default shell preference

# Linux Accounts

- A username is (typically) a sequence of alphanumeric characters of length no more than 8:
  - *eg. jlockman or istc00, istc01, ...*
- The username is the primary identifying attribute of your account
- the name of your home directory is usually related to your username:
- *eg. /home/jlockman*

# Linux Accounts

- A password is a secret string that only the user knows (not even the system knows it)
- When you enter your password the system encrypts it and compares to a stored string
- passwords are (usually) no more than 8 characters long.
- It's a good idea to include numbers and/or special characters (don't use an english word, as this is easy to crack)

# Linux Accounts

- Linux includes the notion of a "group" of users
- A Linux group can share files and active processes
- Each account is assigned a "primary" group
- The *groupid* is a number that corresponds to this primary group
- In Linux-speak, groupid's are known as *GID's*
- A single account can belong to many groups (but has only one primary group)



# Interacting with the Shell

Type a command (**ls**) at the prompt (**login3\$**) and press ENTER

Example: **login3\$ ls**

- Shell starts a new process for executing the requested command , the new process executes the command and the shell displays any output generated by the command
- When the process completes, the shell displays the prompt and is ready to take the next command
- Specific information is passed to the command via more arguments
- The shell is killed by “exit” or CTRL-D

**login3\$ exit**

**logout**

# Files and File Names

- A file is a basic unit of storage (usually storage on a disk)
- Every file has a name
- File names can contain any characters (although some make it difficult to access the file)
- Unix file names can be long!
  - how long depends on your specific flavor of Unix

# A Bit about Directories and Files

- Linux/Unix stores **files** in **directories**.
- Directories are hierarchical—an inverse-tree organization. So, a given directory can have many directories in it (as well as many files)
  - This is like a folder having folders in it, in OS X and Windows (in fact, it's exactly the same thing)
- The 'root' (top) directory in Linux/Unix is **“/”**
  - every other directory is /something(/something...)
  - forward slash is used to separate directory and file names
  - User 'home' directories are often something like:
    - /home/username, or
    - /users/username

# More about File Names

- Every file must have a name
- Each file in the same directory must have a unique name
- Files that are in different directories can have the same name
- Note: Unix is case-sensitive
  - So, “texas-fight” is different than “Texas-Fight”

# Directories

- A *directory* is a special kind of file - Unix uses a directory to hold information about other files
- We often think of a directory as a container that holds other files (or directories)
- Mac and Windows users can relate a *directory* to the same idea as a *folder*

# Directories

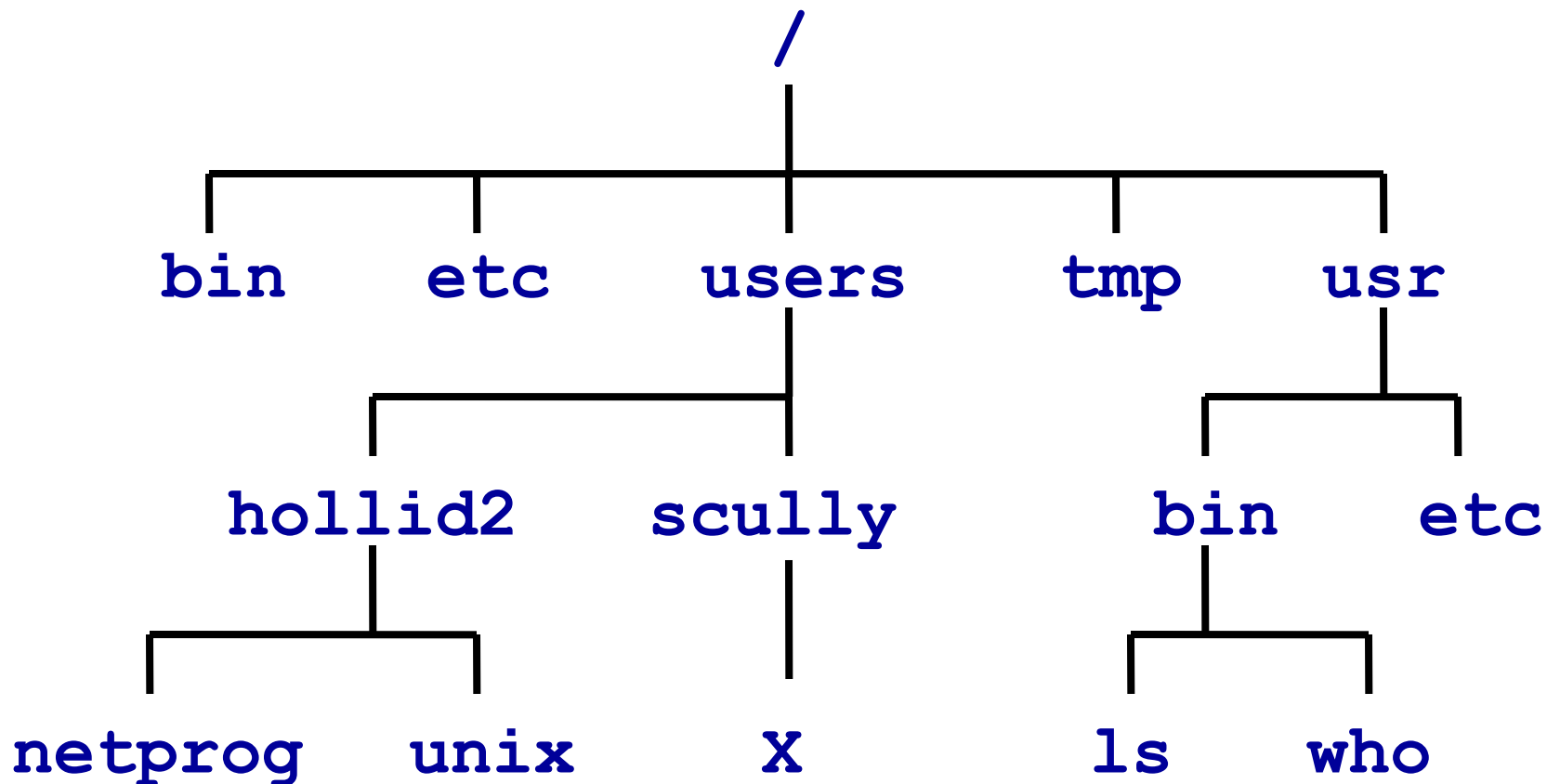
What is a *working directory*?

The directory your shell is currently associated with. At anytime in the system your login is associated with a directory

**pwd** – view the path of your working directory

**ls** – view your working directory

# Unix Filesystem (an upside-down tree)



# Finding your home

Each user has a home directory which can be found with:

**cd**

**cd** *~jlockman*

**cd** *\$HOME*

The tilde character ‘~’ will tell the shell to auto-complete the path statement for the **cd** command

*\$HOME* refers to an *environment variable* which contains the path for home.



# Relative vs.. Absolute Path

Commands expect you to give them a path to a file. Most commands will let you provide a file with a relative path, or a path relative to your working directory.

../directory - the '..' refers to looking at our previous directory first

./executable - '.' says this directory, or our working directory

Absolute, or Full paths are complete. An easy way to know if a path is absolute is does it contain the '/' character at the beginning?

/home/user/directory/executable - a full path to file executable

# More file commands

**cd** *directory* - change your current working directory to the new path

**ls -a** – show hidden files

Hidden files are files that begin with a period in the filename ‘.’

**mv** - moves one file to another

**cp** – copies files or directories

**rm** – remove files & directories

**rm -rf** – remove everything with no warnings

**rm -rf \*** - most dangerous command you can run!

# Recursive Directories

Oftentimes a manual will refer to 'recursive' actions on directories. This means to perform an action on the given directory and recursively to all subdirectories.

**cp -R** *source destination* – copy recursively all directories under source to destination

# Poking around in \$HOME

How much space do I have?

**quota** – command to see all quotas for your directories are, if any.

How much space am I taking up?

**du** - command to find out how much space a folder or directory uses.

**df** – display space information for the entire system

# Helpful Hints on Space

Almost all commands that deal with file space will display information in Kilobytes, or Bytes. Nobody finds this useful.

Many commands will support a ‘-h’ option for “Human Readable” formatting.

**ls -lh** - displays the working directory files with a long listing format, using “human readable” notation for space

# Permissions

- The \*NIX systems are multi-user environments where many users run programs and share data. Files and directories have three levels of permissions: World, Group, and User.
- The types of permissions a file can contain are:

Read Permissions	Write Permissions	Execute Permissions
r	w	x

# Permissions Cont.

- File permissions are arranged in three groups of three characters.
- In this example the owner can read & write a file, while others have read access

User (owner)	Group	Others (everyone else)
rw-	r--	r--

# Changing Permissions

- **chmod** – change permissions on a file or directory
- **chgrp** and **chown** – change group ownership to another group (only the superuser can change the owner)
  - Both options support '-R' for recursion.



# All About Me

Every userid corresponds to a unique user or system process

**whoami** – returns the userid of the current user

**passwd** – change password

What is my group? – G-81769

```
slogin1$ ls -l ~jlockman
total 12
-rwxr--r--  1 jlockman G-81769 18 Jan 27 12:04 bar
-rwxr--r--  1 jlockman G-81769 13 Jan 27 12:04 baz
-rwxrwxrwx  1 jlockman G-81769 37 Jan 27 12:04 foo
-rwxr-xr-x  1 jlockman G-81769  0 Jan 27 12:05 someFile
```

# Everyone else

- **who** – show all other users logged in
- **finger** – show detailed information about a user

```
slogin1$ finger jlockman
Login: jlockman                Name: John Lockman III
Directory: /home/00944/jlockman      Shell: /bin/bash
On since Tue Jan 27 13:15 (CST) on pts/0 from lockman-d620.tacc.utexas.edu
New mail received Sat Aug 30 15:34 2008 (CDT)
      Unread since Tue Aug 26 12:34 2008 (CDT)
Plan:
High Performance Computing Specialist
Texas Advanced Computing Center
jlockman@tacc.utexas.edu
```

# Basic Commands (1)

- To print the name of the current/working directory, use the **pwd** command

```
login4$ pwd  
/share/home/01698/rauta
```

- To make a new directory, use the **mkdir** command

```
login4$ mkdir ssc322
```

- To change your working directory, use the **cd** command

```
login4$ cd ssc322
```

# Basic Commands (2)

- To create a new file use the **vi** command  
**login4\$ vi test.txt**
  - Press **i** to start **inserting** text
  - Type some text: **Hello Class 322**
  - To **save and quit**, press Esc key, and enter **:wq!**  
(press the enter key after typing **:wq!**)
  - To **quit without saving**, press Esc key if in insert mode, and enter **:q!**
- To display the contents of the file, use the **cat** (short for concatenation) command  
**login4\$ cat test.txt**

## Basic Commands (3)

- To list the contents of a directory, use the **ls** command

```
login4$ ls
```

- To see all files and directories, including hidden ones use the **-a** flag with the **ls** command. Hidden files have a "." in front of them

```
login4$ ls -a
```

**Note: your current working directory can be checked by using the `pwd` command.**

# Basic Commands (4)

- To copy contents of one file to another, use the **cp** command

```
login4$ cp test.txt copytest.txt
```

```
login4$ cp test.txt test3.txt
```

One more example:

```
login4$ mkdir junk
```

```
login4$ cp test.txt ./junk/test2.txt
```

(The command above copies a file to the sub-directory **junk**)

```
login4$ cd junk
```

```
login4$ ls
```

```
login4$ cd ..
```

- To go a level up from the current working directory

```
login4$ cd ..
```

# Basic Commands (5)

- To remove a file, use the **rm** command  
`login4$ rm test2.txt`
- To remove a directory, use the **-r** option with the **rm** command  
`login4$ rm -r junk2`
- You can also use the **rmdir** command to remove an empty directory  
`login4$ rmdir junk2`

**Note:** **rmdir** command does not have **-r** option

# Basic Commands (6)

- A file can be renamed by moving it. The same can be achieved by using the **mv** command

```
login4$ mv test3.txt newtest3.txt
```

- Use the **man** command to get more information about a command – it is like using help in Windows

```
login4$ man rmdir
```

- Use the **diff** command to see the differences in two files

```
login4$ diff test.txt newtest3.txt
```



## Basic Commands (7)

- Previously executed commands in a shell can be viewed by using the **history** command. For example:

```
login4$ history
```

```
1  man ls
```

```
2  ls -ltr
```

```
3  ls -l -t -r
```

```
4  ls -ltr
```

```
5  history
```

## Basic Commands (8)

- If the contents to display are more than one page, you could use the **more/less** command for paging through text a screenful at a time

```
login4$ more test.txt
```

```
login4$ less test.txt
```

(**less** allows both fwd and bwd movement)

# Basic Commands (9)

## Creating a tarball

- TAR (Tape Archive) command bundles files and sub-directories together and creates an archive (known as tar file or tarball)
- To create a tarball of all the files and sub-directories in the directory ssc329 that you created in Exercise 1, use **c** flag:

```
tar -cvf mytar.tar *
```

- To extract the contents of a tar file use **x** flag:

```
login1$ tar -xvf mytar.tar
```

# What everyone else is up to

- **top** – show a detailed, refreshed, description of running processes on a system.
- **uptime** – show the system load and how long the system has been up.
- ‘load’ is a number based on utility of the cpu’s of the system. A load of 1 indicates full load for one cpu.

```
slogin1$ uptime  
13:21:28 up 13 days, 20:12, 23 users,  load average: 2.11, 1.63, 0.91
```

# Working With Programs

- Commands or programs on the system are identified by their filename and by a process ID which is a unique identifier.
  - ps – display process information on the system
  - kill pid – terminates the process id
  - ^c (control+c) terminates the running program
  - ^d (control+d) terminates your session.
- Only you and the superuser (root) has permissions to kill processes you own.

# Advanced Program Options

- Often we must run a command in the background with the ampersand ‘&’ character  
    `command -options &`  
    runs command in background, prompt returns immediately
- Match zero or more characters wildcard ‘\*’  
    `cp * destination`  
    copy everything to destination  
    This option can get you into trouble if misused

# Input and Output

- Programs and commands can contain an input and output. These are called 'streams'. Unix programming is oftentimes stream based.
  - Programs also have an error output. We will see later how to catch the error output.

STDIN – 'standard input,' or input from the keyboard

STDOUT – 'standard output,' or output to the screen

STDERR – 'standard error,' error output which is sent to the screen.

# File Redirection

- Oftentimes we want to save output (stdout) from a program to a file. This can be done with the 'redirection' operator.

```
myprogram > myfile
```

using the '>' operator we redirect the output from  
myprogram to file myfile

- Similarly, we can append the output to a file instead of rewriting it with a double '>>'

```
myprogram >> myfile
```

using the '>' operator we append the output from  
myprogram to file myfile



# Input Redirection

- Input can also be given to a command from a file instead of typing it to the screen, which would be impractical.  
`cat programinput > mycommand`
- This command series starts with the command 'cat' which prints a file to the screen. programinput is printed to stdout, which is redirected to a command mycommand

# Redirecting stderr

- Performing a normal redirection will not redirect stderr. In Bash, this can be accomplished with '2>'

```
command 2> file1
```

- Or, one can merge stderr to stdout (most popular) with '2>&1'

```
command > file 2>&1
```

# Pipes

- Using a pipe operator '|' commands can be linked together. The pipe will link the standard output from one command to the standard input of another.
- Very helpful for searching files

# Searching

A large majority of activity on Unix systems involve searching for files and information.

**find** – utility to find files

**grep** – the best utility ever written for Unix, searches for patterns inside files and will return the line, if found

```
slogin1$ find . -name foobar
./test_dir/foobar
slogin1$ cat ./test_dir/foobar
=====
*
    This is the file I searched for!
*
=====
```

# Compression using gzip

- `slogin1$ du -h bigfile`
- `32Kbigfile`
- `slogin1$ gzip bigfile`
- `slogin1$ du -h bigfile.gz`
- `4.0K bigfile.gz`

# Unix vs.. Windows files

- File formats are different between the two operating systems
- Use the Unix command `dos2unix` to convert files – especially script files - created on Windows, so they will work on Unix

# Using tar to create compressed files

- Tar will create compressed files for you
  - **tar -czvf mytarfile.tar.gz directory**
    - creates a compressed file named *mytarfile.tar.gz* containing all of the files in the directory *directory*
  - **tar -xzvf mytarfile.tar.gz**
    - uncompresses all directories and files inside the file *mytarfile.tar.gz* into the working directory

# Connecting to Another Machine

- Secure Shell vs Restricted Shell
  - **ssh** is an encrypted remote login program that is 'secure' to trust across non secure networks.
- **ssh** *userid@hostname*



# Copying Files to Remote Hosts

- copy local file *lfile* to *rfile* on remote machine *rsys*
  - **scp** *lfile rsys:rfile*
    - **-p** preserves modification time, access time and mode from original
      - **scp -p** *lfile rsys:rfile*
- copy *rfile* from remote machine *rsys* to local file *lfile*
  - **scp -p** *rsys:rfile lfile*

# Running Commands on a Remote Host

- Commands can be executed on a remote host with **ssh**
- **ssh** *userid@hostname* "ls"
  - Run ls on remote host hostname

# My Environment

- View all system variables by the command '**env**'
- Depending on shell, startup commands can be managed with the files .profile for bash and .cshrc with c shell

# Basic Shell Scripts

- Many times it is helpful to create a ‘script’ of commands to run instead of typing them in individually. Scripts can be made to aid in post-processing, system administration, and automate menial tasks
- `#!/bin/bash`
  - First statement inside a script, will list which shell to run this script in
- `#` - says what will follow is a comment and not to execute

# Basic Shell Scripts

## Variables

- By convention system variables are capitalized
  - HOME – location of the home directory
  - OLDPWD – location of the previous working directory
  - PATH – locations to look inside for executable files
- Setting system variables differs by shell. bash uses **export**, csh uses **setenv**
- User defined variables in scripts are lower-case by convention
  - myvariable=10
    - sets myvariable to 10
  - **echo** \$myvariable
    - prints myvariable

# Basic Shell Scripts

## Conditionals

```
if condition
then
    condition is zero (true - 0)
    execute all commands up to else
statement
else
    if condition is not true then
    execute all commands up to fi
fi
```

# Basic Shell Scripts

## Performing Loops

Loops are statements that are repeated until the conditions are met.

```
for { variable name } in { list }  
do  
    execute one for each item in the list until the  
    list is not finished (And repeat all statement  
    between do and done)  
done
```

```
for i in 1 2 3 4 5  
do  
    echo "Welcome $i times"  
done
```

# Basic Shell Scripts

## Putting it Together

```
#!/bin/bash
#my first script
#scp replacement

remotefile=mydata
localfile=mydata
myserver=dstanzi@lonestar.tacc.utexas.edu
mylsinfo=`ssh $myserver ls $remotefile 2>&1`
ismissing=`echo $mylsinfo | grep ERROR`
if [ "$ismissing" ]
then
    echo "$remotefile not found! Exiting!"
else
    ssh $myserver -n "cat < $remotefile" > $localfile
fi
```



# Basic Shell Scripts

## More...

- `mylsinfo=`ssh $myserver ls $remotefile 2>&1``
  - `Backticks` are used to place output from a command into a variable
- `if [ "$ismissing" ]`
  - Is \$ismissing set (has a value)? If so then the expression is true, otherwise false

# Text Editing

- To be productive in this class, you'll need to be able to use a text editor, to write and edit your code.
  - Microsoft Word is not a Text Editor 😊
- You have a couple of options:
  - Edit locally on your machine, and transfer files (via scp/sftp) to the machine you run your program on.
    - Ultimately, you will find this is annoying
  - Learn to use a text editor on the UNIX system

# Text Editors on (most) \*nix Systems

- Pico/Nano
  - Very simple to use, you can learn it in 10 minutes.
  - Usable, will get you through class.
  - Not very sophisticated.
- Vi or EMACS
  - Steeper learning curve (the first 10 minutes will be painful).
  - Much more powerful (the next 30 years will be smoother).
  - Choosing between Vi or EMACS is like picking a religion.
- Let me give you a short demo of Nano and Vi...

# References

- [http://code.google.com/edu/tools101/linux/basics.html#the command line](http://code.google.com/edu/tools101/linux/basics.html#the_command_line)
- [http://www.tacc.utexas.edu/documents/13601/118360/LinuxIntro\\_HPC\\_09+11+2011\\_hliu.pdf](http://www.tacc.utexas.edu/documents/13601/118360/LinuxIntro_HPC_09+11+2011_hliu.pdf)
- <http://www.cis.uab.edu/courses/cs333/spring2005/>
- [http://www.med.nyu.edu/rcr/rcr/nyu\\_vms/Unix-Editors.html](http://www.med.nyu.edu/rcr/rcr/nyu_vms/Unix-Editors.html)
- <http://www.shelldorado.com/articles/mailattachments.html>