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Linux Training
for New Users of Cluster

Georgia Advanced Computing Resource Center

University of Georgia

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Overview

- GACRC
- Linux Operating System
- Shell, Filesystem, and Common Commands
- Scripting and execution

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Who Are We:

- **G**eorgia **A**dvanced **C**omputing **R**esource **C**enter (**GACRC**)
- Collaboration between the Office of Vice President for Research (**OVPR**) and the Office of the Vice President for Information Technology (**OVPIT**)
- Guided by a faculty advisory committee (GACRC-AC)

Why Are We Here?

- To provide computing hardware and network infrastructure in support of high-performance computing (**HPC**) at UGA

Where Are We?

- http://gacrc.uga.edu (Web)
- http://wiki.gacrc.uga.edu (Wiki)
- http://gacrc.uga.edu/help/ (Web Help)
- https://wiki.gacrc.uga.edu/wiki/Getting_Help (Wiki Help)

- Introduction to Linux
- Connecting to a Linux machine

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Linux Operating System

- Operating System (**OS**)
  - Software program
  - Enables hardware to communicate and operate with software
  - Manages all resources and applications
    - Memory, File system, Networking, I/O, etc.
    - Browser, Video player, etc.

- Most popular Operating Systems : Mac, Linux, Windows.

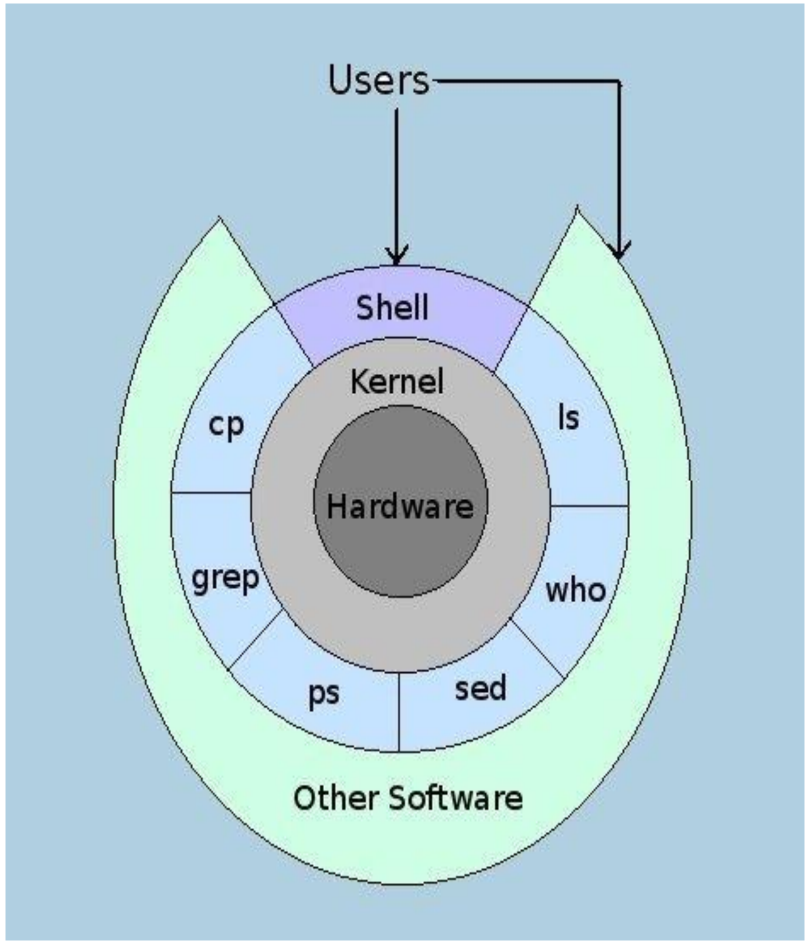
Linux Operating System

- About Linux OS
  - Developed in 1991 by Linus Torvalds
  - Open Source
  - Multi-user, Multi-tasking operating system
  - Most popular OS in the high performance computing community
  - Several distributions - Ubuntu, CentOS, Fedora, RedHat, etc.

- Why use Linux?
  - Free, Stable, Secure, Portable, Scalable

Linux Operating System

- Two major components of Linux:
  - **Kernel**
    - Core of the OS
    - Schedules processes, and interfaces with hardware
    - Manages resources – memory, I/O, etc
  - **Shell**
    - The shell is an interface between users and the kernel
    - Command-line – Users can type commands
    - Command interpreter – runs commands
    - Programming environment – for scripting



Linux Shell

- “Shell” - **command line interpreter**
  - Interacts between the system and users
    - Reads commands from the keyboard
    - Executes commands
    - Displays the output
  - Provides the “environment”
    - Command-line completion
    - Auto-correction
    - TAB key - Auto-completion
    - Up ⬆ and down ⬇ arrow keys - command history
  - Several shells available
    - **Bash-shell** (bash) is the default one.

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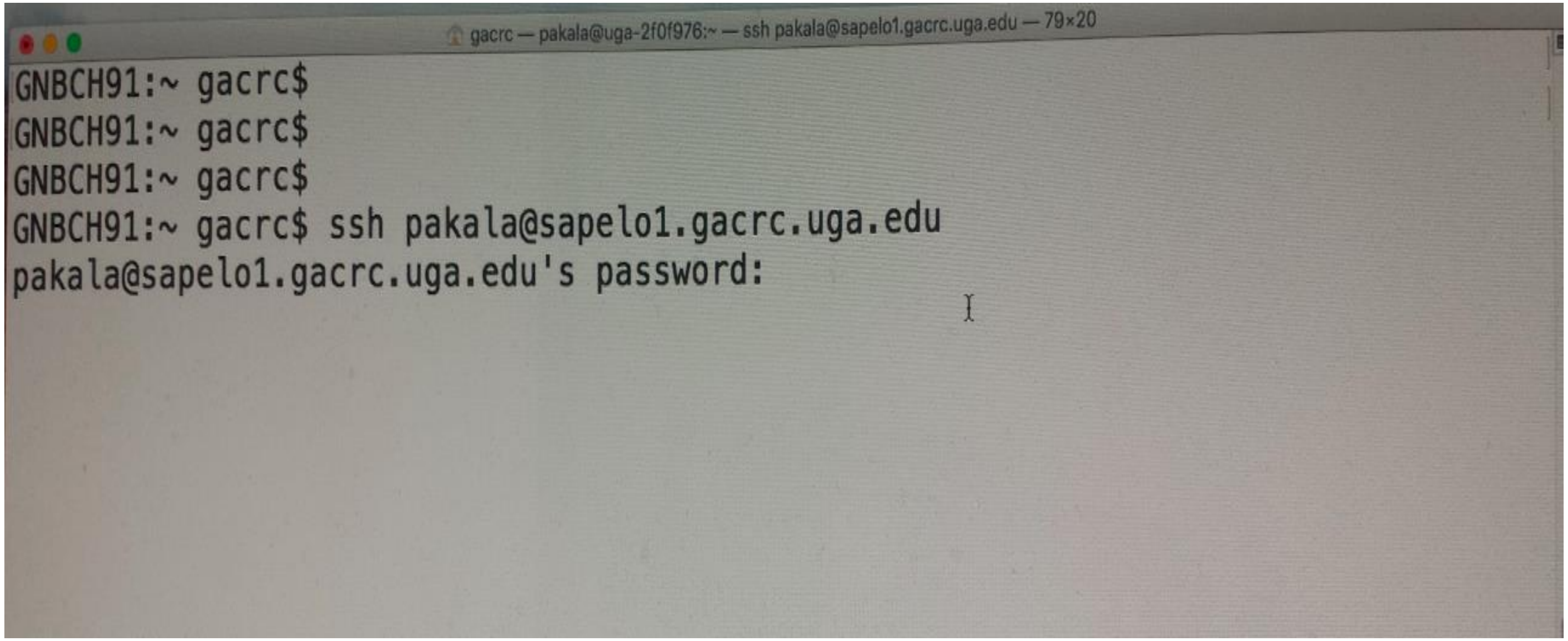
Connecting to Shell - on Mac/Linux

- Open a terminal and type: **ssh <UGAMyID>@sapelo1.gacrc.uga.edu**
- Enter your Password when prompted
  - Note: The password entry will not show on the screen. Not even asterisks.



```
gacrc — pakala@uga-2f0f976:~ — ssh pakala@sapelo1.gacrc.uga.edu — 79×20
GNBCH91:~ gacrc$
GNBCH91:~ gacrc$
GNBCH91:~ gacrc$
GNBCH91:~ gacrc$ ssh pakala@sapelo1.gacrc.uga.edu
pakala@sapelo1.gacrc.uga.edu's password:
```

Connecting to Shell – on Windows

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➢ Download SSH Secure Shell from http://eits.uga.edu/hardware_and_software/software/

1. Open the SSH Secure Shell and click on "**Quick connect**".

2. Hostname: **sapelo1.gacrc.uga.edu**

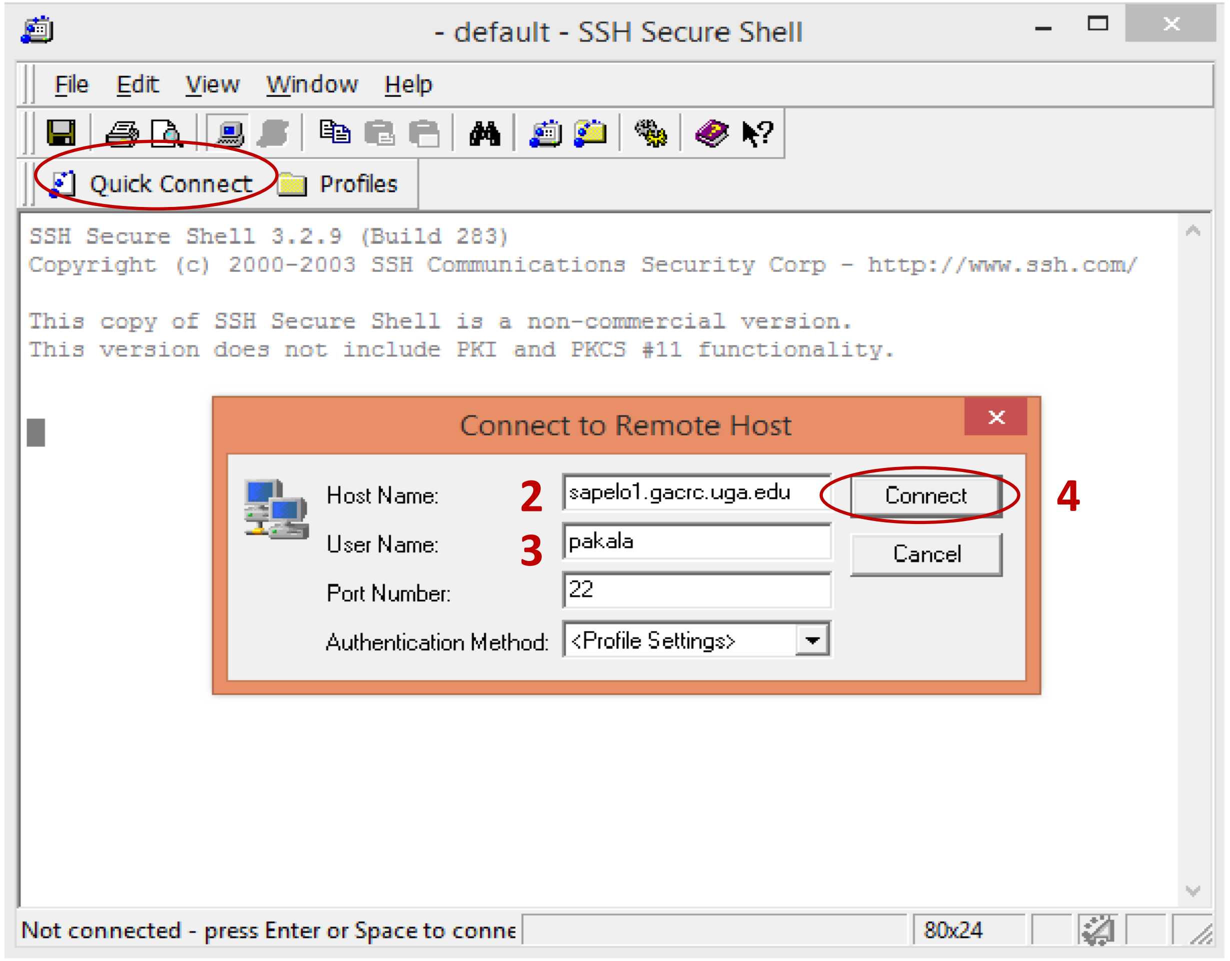
3. User Name: **your UGA MyID**

➢ Port Number: 22

➢ Authentication Method: Select <Profile Settings>

4. Enter above information and click "**Connect**"

➢ Enter your password in the next pop up window and click "OK"

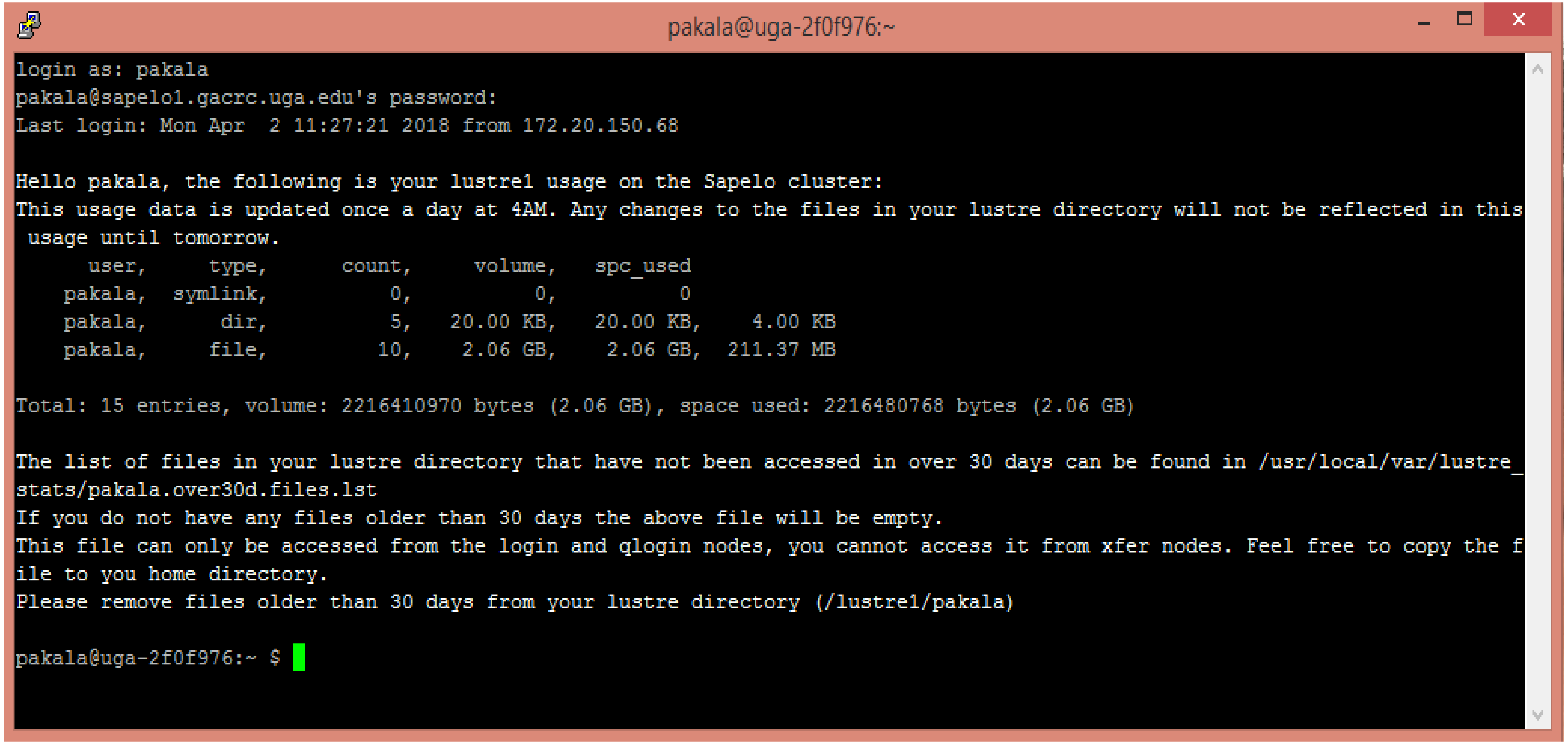


- default - SSH Secure Shell
File Edit View Window Help
1
Quick Connect
Profiles
Connect to Remote Host
2
3
Connect
4
Cancel
Not connected - press Enter or Space to conne
80x24

```
SSH Secure Shell 3.2.9 (Build 283)
Copyright (c) 2000-2003 SSH Communications Security Corp - http://www.ssh.com/

This copy of SSH Secure Shell is a non-commercial version.
This version does not include PKI and PKCS #11 functionality.
```

Host Name: sapelo1.gacrc.uga.edu
User Name: pakala
Port Number: 22
Authentication Method: <Profile Settings>

Connecting to Sapelo1

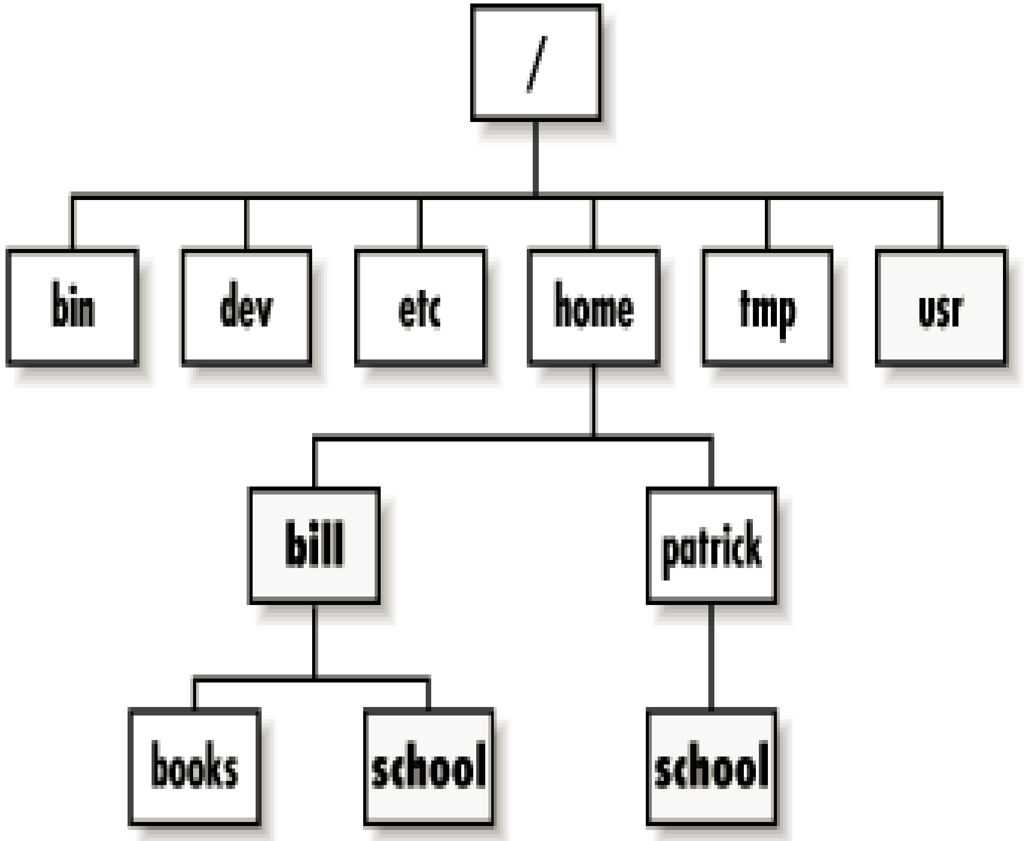

pakala@uga-2f0f976:~

```
login as: pakala
pakala@sapelo1.gacrc.uga.edu's password:
Last login: Mon Apr  2 11:27:21 2018 from 172.20.150.68

Hello pakala, the following is your lustre1 usage on the Sapelo cluster:
This usage data is updated once a day at 4AM. Any changes to the files in your lustre directory will not be reflected in this
 usage until tomorrow.
      user,     type,      count,     volume,   spc_used
    pakala,  symlink,          0,          0,          0
    pakala,      dir,          5,   20.00 KB,   20.00 KB,    4.00 KB
    pakala,     file,         10,    2.06 GB,    2.06 GB,  211.37 MB

Total: 15 entries, volume: 2216410970 bytes (2.06 GB), space used: 2216480768 bytes (2.06 GB)

The list of files in your lustre directory that have not been accessed in over 30 days can be found in /usr/local/var/lustre_
stats/pakala.over30d.files.lst
If you do not have any files older than 30 days the above file will be empty.
This file can only be accessed from the login and qlogin nodes, you cannot access it from xfer nodes. Feel free to copy the f
ile to you home directory.
Please remove files older than 30 days from your lustre directory (/lustre1/pakala)

pakala@uga-2f0f976:~ $ 
```

- ➢ Linux Directory Structure
- ➢ Navigation Commands

Understanding Linux Directory Structure

- **‘upside down tree’**
- **Root directory** (“/” forward slash)
- Organized inside root directory
- Create directories inside - **sub directories**
- Unique name in its containing directory



Relative Path vs Absolute Path

- **Relative path**
  - Path to a file, relative to current location (present working directory)

```
$ pwd                          Present working directory
/home/pakala/

$ ls
Suchi_Scripts    Blast

$ ls Blast                     Relative Path
AF293          Escherichia_Coli_LF82.fasta
blast.sh       GCF_000002655.1_genomic.fna
```

- **Absolute or Full path**
  - Path to a file, beginning at the root

```
$ ls /home/pakala/Blast/       Absolute path
AF293          Escherichia_Coli_LF82.fasta
blast.sh       GCF_000002655.1_genomic.fna
```

Change Directory (cd)

- **cd** :change your current working directory

```
pakala@uga-2f0f976:~ $ cd /usr/bin     ⟵   Move to bin subdir of usr dir

pakala@uga-2f0f976:~ $ cd ..           ⟵   Move up one directory

pakala@uga-2f0f976:~ $ cd              ⟵   Returns to home directory

pakala@uga-2f0f976:~ $ cd ~pakala      ⟵   Returns to home directory/pakala

pakala@uga-2f0f976:~ $ cd $HOME        ⟵   Environment Variable/home dir
```

- **pwd** :present working directory

```
pakala@uga-2f0f976:~ $ pwd
/home/pakala
```

List Directory (ls)

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- **ls**
  - lists files and directories that exist in the current location
    - Note: we cannot differentiate between files and directories

```
pakala@uga-2f0f976:~ $ ls
e_coli_data.fq  hello.sh  sample_script  sub.sh  Suchi_Scripts
```

- **ls –l**
  - shows file permissions, owner of file, group, file size, modified date and time, and differentiates between file or directory name.

```
pakala@uga-2f0f976:~ $ ls -l
total 584496
-rw-r--r-- 1 pakala abclab 1610499990 Mar  6 09:46 e_coli_data.fq
-rwxr----- 1 pakala abclab        136 Feb 21 15:22 sample_script
-rw-r--r-- 1 pakala abclab        284 Mar  6 09:50 sub.sh
drwxr-xr-x 2 pakala abclab          2 Feb 22 12:07 Suchi_Scripts
```

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List Directory (ls)

- **ls -a**
  - Lists hidden files. They start with '.'
  - These are files containing profiles and other settings that should not be altered unless necessary, and hence are "hidden"

```
pakala@uga-2f0f976:~ $ ls -a
.                     .bash_history.n609            .emacs        .mozilla
..                    .bash_history.sapelo2-sub1    .emacs.d      .oracle_jre_usage
.bash_history         .bash_history.sapelo2-sub2    .felix        sample_script
.bash_history.n201    .bash_logout                  .fontconfig   .ssh
.bash_history.n204    .bash_profile                 .gnome2       sub.sh
.bash_history.n206    .bashrc                       hello.sh      Suchi_Scripts
.bash_history.n210    .beast                        .java         .swp
.bash_history.n227    .cache                        .ldaprc       .viminfo
.bash_history.n233    .config                       .lmod.d
.bash_history.n234    e_coli_data.fq                .matlab
```

List Directory (ls)

- **ls -lh**
  - shows sizes in human readable format

```
pakala@uga-2f0f976:~ $ ls -lh
total 571M
-rw-r--r-- 1 pakala gclab 1.5G Mar  6 09:46 e_coli_data.fq
-rwxr----- 1 pakala gclab  136 Feb 21 15:22 sample_script
-rw-r--r-- 1 pakala gclab  284 Mar  6 09:50 sub.sh
drwxr-xr-x 2 pakala gclab    2 Feb 22 12:07 Suchi_Scripts
```

- **ls -lS**
  - Displays file size in order

```
pakala@uga-2f0f976:~ $ ls -lS
total 584496
-rw-r--r-- 1 pakala gclab 1610499990 Mar  6 09:46 e_coli_data.fq
-rw-r--r-- 1 pakala gclab        284 Mar  6 09:50 sub.sh
-rwxr----- 1 pakala gclab        136 Feb 21 15:22 sample_script
drwxr-xr-x 2 pakala gclab          2 Feb 22 12:07 Suchi_Scripts
```

- Files
- Permissions
- Creation, Deletion, Copy and Move Commands

Files And Processes

- File
  - Collection of data
  - Location of a file – Path
  - Can be created using text editors (nano, vi, etc)

- Process
  - Any program that is run
  - Unique process identifier - PID
  - For example: “ps” command which lists all processes

```
pakala@uga-2f0f976:~ $ ps
  PID TTY          TIME CMD
21505 pts/225  00:00:00 bash
24908 pts/225  00:00:00 ps
```

Files And File Names

- File
  - Basic unit of storage for data
  - May contain any characters
  - File names are always **case sensitive**
  - You should **avoid spaces, quotes, and parenthesis**
  - File names can be long, up to 255 characters
- Directory
  - Special type of file
  - Holds information about other files
  - Present working directory (pwd)

```
pakala@uga-2f0f976:~ $ pwd
/home/pakala
```

File Permissions

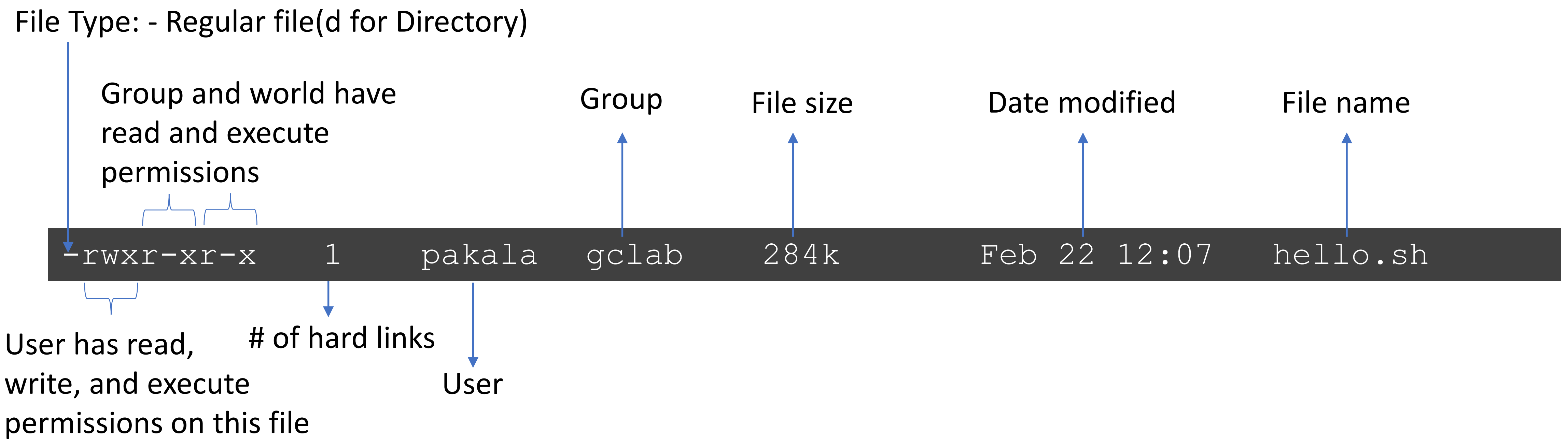
- Multi-user environment
- File permissions are used to protect users and system files.
- The types of permissions a file can have are:

Read Permissions	Write Permissions	Execute Permissions
r	w	x

- Files and directories have three levels of permissions:
  - **User**
  - **Group**
  - **World**

User (owner)	Group	Others (everyone else)
rwx	rwx	rwx

File Permissions


File Type: - Regular file(d for Directory)
Group and world have read and execute permissions
Group
File size
Date modified
File name
User has read, write, and execute permissions on this file
# of hard links
User

```
-rwxr-xr-x   1    pakala  gclab    284k       Feb 22 12:07   hello.sh
```

Changing File Permissions

- **chmod** command to change permissions of a file.
  - Symbolic mode:
    - Syntax: chmod [references][operator][modes]
    - References – "**u**" for user, "**g**" for group, "**o**" others
    - "**a**" for all three types
    - The operator – "**+**" to add and "**-**" to remove

```
>> Default settings when file was created:
pakala@uga-2f0f976:~ $ ls -l
-rw-r--r-- 1 pakala gclab   24 Feb 15 10:35 sample_script
```

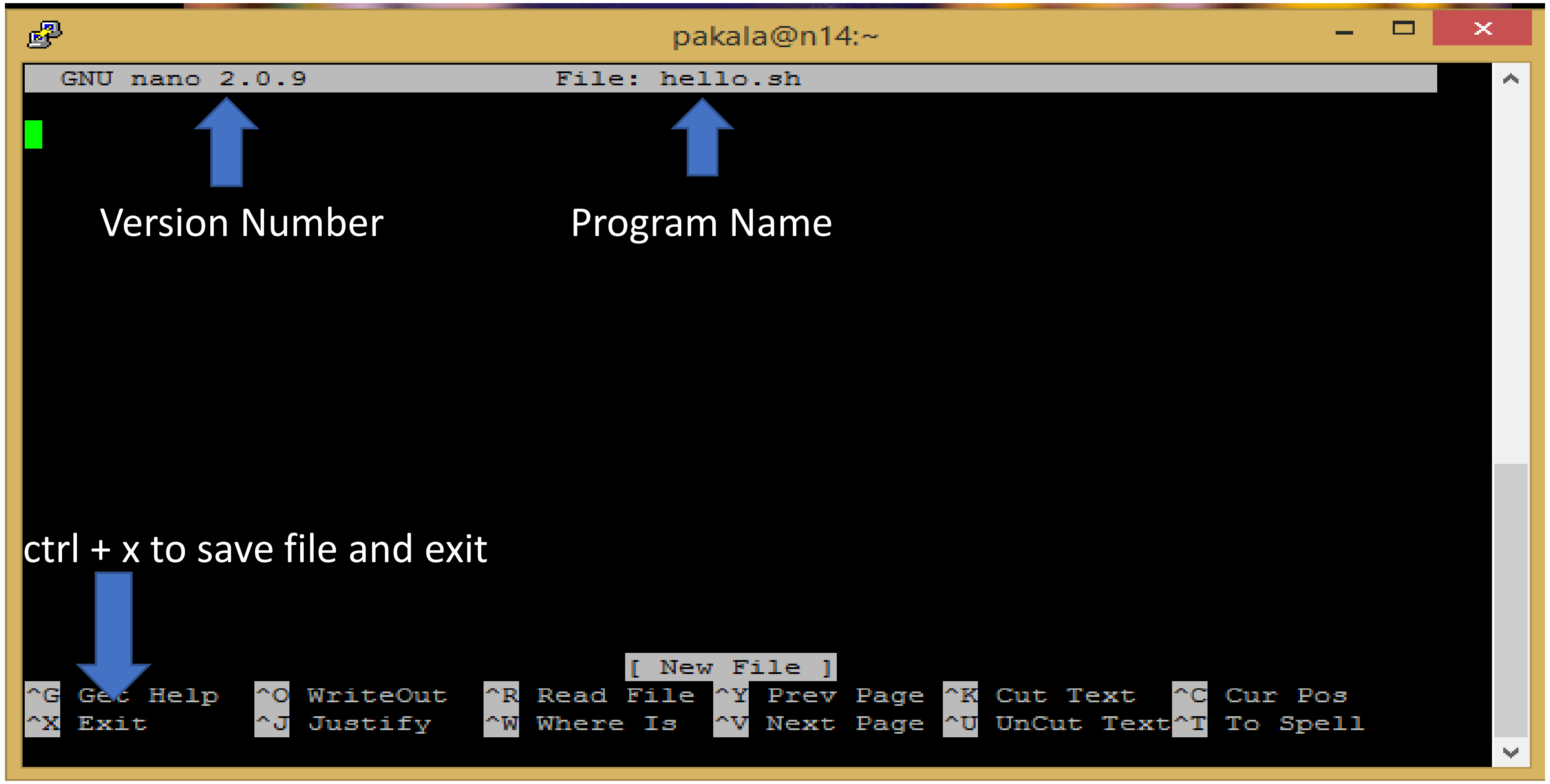
```
>> Adding x(excute) permission for the user:
$ chmod u+x sample_script
-rwxr--r-- 1 pakala gclab   24 Feb 15 10:45 sample_script
```

```
>> Removing r(read) permission for others:
$ chmod o-r sample_script
-rwxr----- 1 pakala gclab   24 Feb 15 10:50 sample_script
```

Creating and Editing Files

- Creating and editing files using a text editor
- The most widely used editors available on sapelo are vim, **nano**, etc

```
$ nano hello.sh
```



pakala@n14:~

```
  GNU nano 2.0.9                 File: hello.sh




                                 [ New File ]
^G Get Help   ^O WriteOut   ^R Read File  ^Y Prev Page  ^K Cut Text   ^C Cur Pos
^X Exit       ^J Justify    ^W Where Is   ^V Next Page  ^U UnCut Text ^T To Spell
```

Creating and Deleting Directories

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- **mkdir** creates a directory

```
$ mkdir testdir
```

- Creating directories and subdirectories in one step

```
$ mkdir -p <dirname>/<subdirname>
```

- **rmdir** removes an empty directory

```
$ rmdir testdir
```

- Remove directories

```
$ rm -ri <directoryname>      ➔ Interactive Mode
```

- Removing Files

```
$ rm -i <filename>            ➔ Interactive Mode
```

Remove Files (rm)

- **rm** removes files

```
$rm -i /home/pakala/sample_script
```

- **Other options:**

```
option       description
Remove  (unlink)  the FILE(s)
rm -f         ignore nonexistent files, never prompt
rm -i         prompt before every removal
rm -r, -R     remove directories and their contents recursively
rm -v         explain what is being done
```

- With the **-r** or **-R** option
  - Removes entire directories recursively and permanently!!!
- **rm -r *** option
  - Removes all of the files and subdirectories (**not recommended**)
- To remove an empty directory, use **rmdir**

Copy Files (cp)

- **cp** copies files or directories.
- To copy a file from /home/pakala/sample_script to /home/pakala/Suchi_Scripts

```
$ cp -i /home/pakala/sample_script /home/pakala/Suchi_Scripts
```

- **Other Options**:

```
option        description
cp -a         archive files
cp -f         force copy by removing the destination file if needed
cp -i         interactive - ask before overwrite
cp -n         no file overwrite
cp -R         recursive copy (including hidden files)
cp -u         update - copy when source is newer than destination
cp -v         verbose - print informative messages
```

Move Files (mv)

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- **mv** moves a file to another location.
- For example, to move a file from /lustre1/pakala/AF293.fs to /lustre1/pakala/Sample_Data

```
$ mv -i AF293.fs /lustre1/pakala/Sample_Data
```

- Can also be used to **rename** a file in the same directory.
- For example, to rename *myFile* to *myFileNew*:

```
$ mv myFile myFileNew
```

- **Other options:**

```
option        description
mv -f         force move by overwriting destination file without prompt
mv -i         interactive prompt before overwrite
mv -u         update - move when source is newer than destination
mv -v         verbose - print source and destination files
man mv        help manual
```

Summary of Common Linux Commands

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- **cd** : Change your current working directory
- **pwd** : Print absolute path of your current working directory
- **ls** : List the files that exist in the current directory
- **mv** : Moves a file to another location.
- **cp** : Copies files or directories
- **mkdir** : Create a directory
- **rmdir** : Delete an empty directory
- **rm –r** : Delete a nonempty directory and its contents

More Linux Commands

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- **file <filename>** : Display file type of file with name
- **cat textfile** : Throws content of text file on the screen
- **more <filename>** : Output the contents of a file
- **less <filename>** : Output the contents of a file
- **man <command>** : Read man pages command
- **dos2unix :** convert DOS/Windows file to Linux format
- **mac2unix:** convert mac file to Linux format
- **exit or logout**: leave the session

File Viewing

- **file** – determine the type of a file

```
pakala@uga-2f0f976:~ $ file Linux_Scripts/                ⬅  directory
Linux_Scripts/: directory
pakala@uga-2f0f976:~ $ file e_coli_data.fq                ⬅  ASCII text
e_coli_data.fq: ASCII text
pakala@uga-2f0f976:~ $ file hello.sh                      ⬅  Shell Script
hello.sh: Bourne-Again shell script text executable
```

- **cat**
  - cat is a standard Linux utility that concatenates
  - Prints the content of a file to standard output

```
pakala@uga-2f0f976:~ $ cat temp.txt
Hello!!!!!
Welcome to Linux world!
```

File Viewing

- **more**
  - view text files - one page at a time, scroll down only
  - spacebar to scroll down

```
pakala@uga-2f0f976:~ $ more testfile
```

- **less**
  - view text files, one page at a time, scroll up and down
  - space bar to scroll down
  - key **b** to scroll up, Key **q** to quit

```
pakala@uga-2f0f976:~ $ less testfile
```

Manual Pages (man)

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- Linux includes a built in manual for nearly all commands.
- Example: **man rm** (remove)

```
$ man rm
RM(1)                           User Commands                          RM(1)

NAME
    rm - remove files or directories

SYNOPSIS
    rm [OPTION]... FILE...

DESCRIPTION
    This  manual page documents the GNU version of rm.  rm removes each
    specified file. By default, it does not remove directories.

     If the -I or --interactive=once option is given,  and  there  are  more
     than  three  files  or  the  -r,  -R, or --recursive are given, then rm
     prompts the user for whether to proceed with the entire operation.
```

```
OPTIONS
    Remove (unlink) the FILE(s).

       -f, --force
              ignore nonexistent files, never prompt

       -i     prompt before every removal

       -r, -R, --recursive
              remove directories and their contents recursively
```

File Conversion

- **dos2unix** : Convert DOS/Windows file to Linux format
  - Example: dos2unix file1
  - Removes DOS/Windows line endings in file1

```
$ dos2unix file1
```

- **mac2unix** : Convert Mac file to Linux format
  - Example: mac2unix file1
  - Removes Mac line endings in file1

```
$ mac2unix file2
```

- Shell Scripting

- Script Execution

Shell Scripting

- Shell Script - series of commands written in plain text file
- Why to write Shell Script?
  - To automate tasks that should be run daily
  - Build “pipelines” of commands and other programs to run
  - Serve as automatic documentation
  - Useful to create our own commands
  - Save lots of time

Example Script

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```
#!/bin/bash

# rsync using variables

SOURCEDIR=/home/pakala/Linux_Scripts
DESTDIR=/lustre1/pakala/backup_files/

rsync -avh $SOURCEDIR $DESTDIR

# compressing directory

compress=Linux_Scripts_$(date +%Y%m%d).tar.gz
tar -czf $compress /home/pakala

# Simple if/else statement, checking if the directory exists or not

directory="./Suchi_Scripts"

if [ -d $directory ]; then
        echo "Directory exists"
else
        echo "Directory does not exist"
fi
```

Variables in Shell

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- What is a **"variable"**?
  - A character string to which we assign a value
  - Value could be a number, text, filename or any other type of data
  - Pointer to the actual data
- **There are two types of variables:**
  - System variables
  - User defined variables
- **System variables**
  - Created and maintained by Linux
  - Defined in CAPITAL LETTERS, user can reset their default values

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System Variables

System Variable	Meaning	Example Value
HOME	User's home directory	/home/pakala
PATH	Path to binaries	/usr/bin:/sbin:/bin:/usr/sbin
PWD	Current working directory	/home/pakala
SHELL	Path to default shell	/bin/bash
USER	User who is currently logged in	pakala
TERM	Login terminal type of user	xterm
LD_LIBRARY_PATH	Shared library search path	

```
pakala@uga-2f0f976:~ $ echo $SHELL
/bin/bash
```

```
pakala@uga-2f0f976:~ $ echo $HOME
/home/pakala
```

User Defined Variables

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- Created and maintained by user, defined in lower letters
- Syntax: **variable name=value**
- Rules for naming variable name
  - Don't put spaces on either side of the equal sign
  - Variables are **case sensitive**
  - Do not use ?,* etc, to name your variable names
- To print or access user defined variables
  - Syntax: **$variable name**

```
$ no=10
$ echo $no              #will print 10
$ no =25                #no spaces on either side of equal sign
-bash: no: command not found
$ No=11
$ echo $No              #case sensitive, will print 11
```

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Example Script – breaking it down

```
#!/bin/bash                                          Location of shell to use

# rsync using variables                              Comment line

SOURCEDIR=/home/pakala/Linux_Scripts
DESTDIR=/lustre1/pakala/backup_files/

rsync -avh $SOURCEDIR $DESTDIR                       Actual command to run

# compressing directory

compress=Linux_Scripts_$(date +%Y%m%d).tar.gz
tar -czf $compress /home/pakala

# Simple if/else statement, checking if the directory exists or not

directory="./Suchi_Scripts"

if [ -d $directory ]; then
        echo "Directory exists"
else
        echo "Directory does not exists"
fi
```

Run Shell Script

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```
$ chmod u+x sample_script.sh

$ ./sample_script.sh
sending incremental file list
created directory /lustre1/pakala/backup_files
Linux_Scripts/
Linux_Scripts/.swp
Linux_Scripts/car.sh
Linux_Scripts/file2
Linux_Scripts/file2.sh
Linux_Scripts/first.sh
Linux_Scripts/forloop.sh
Linux_Scripts/sample
Linux_Scripts/sampledata.sh
Linux_Scripts/samplescript.sh
Linux_Scripts/test1.sh
Linux_Scripts/whileloop.sh
Linux_Scripts/sample1/

sent 14.68K bytes  received 229 bytes  29.82K bytes/sec
total size is 13.89K  speedup is 0.93
tar: Removing leading `/' from member names
tar: /home/pakala: file changed as we read it
Directory exists
```

Adding execute permission for User

Running the script

.bashrc

- .bashrc is a shell script that Bash runs whenever it is started interactively.
  - Think about all the startup programs that run when you start Windows
- It initializes an interactive shell session. You can put any command in this file that you would type at the command prompt
- A common thing to put in .bashrc are aliases that you want to always be available

```
# .bashrc
# Source global definitions
if [ -f /etc/bashrc ]; then
        . /etc/bashrc
fi
# User specific aliases and functions
export PATH=/home/pakala/bin:$PATH

alias ls='ls --color=auto -l'
alias p="pwd"
```

THANK YOU ☺