STATS 769
Linux and the shell

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Overview

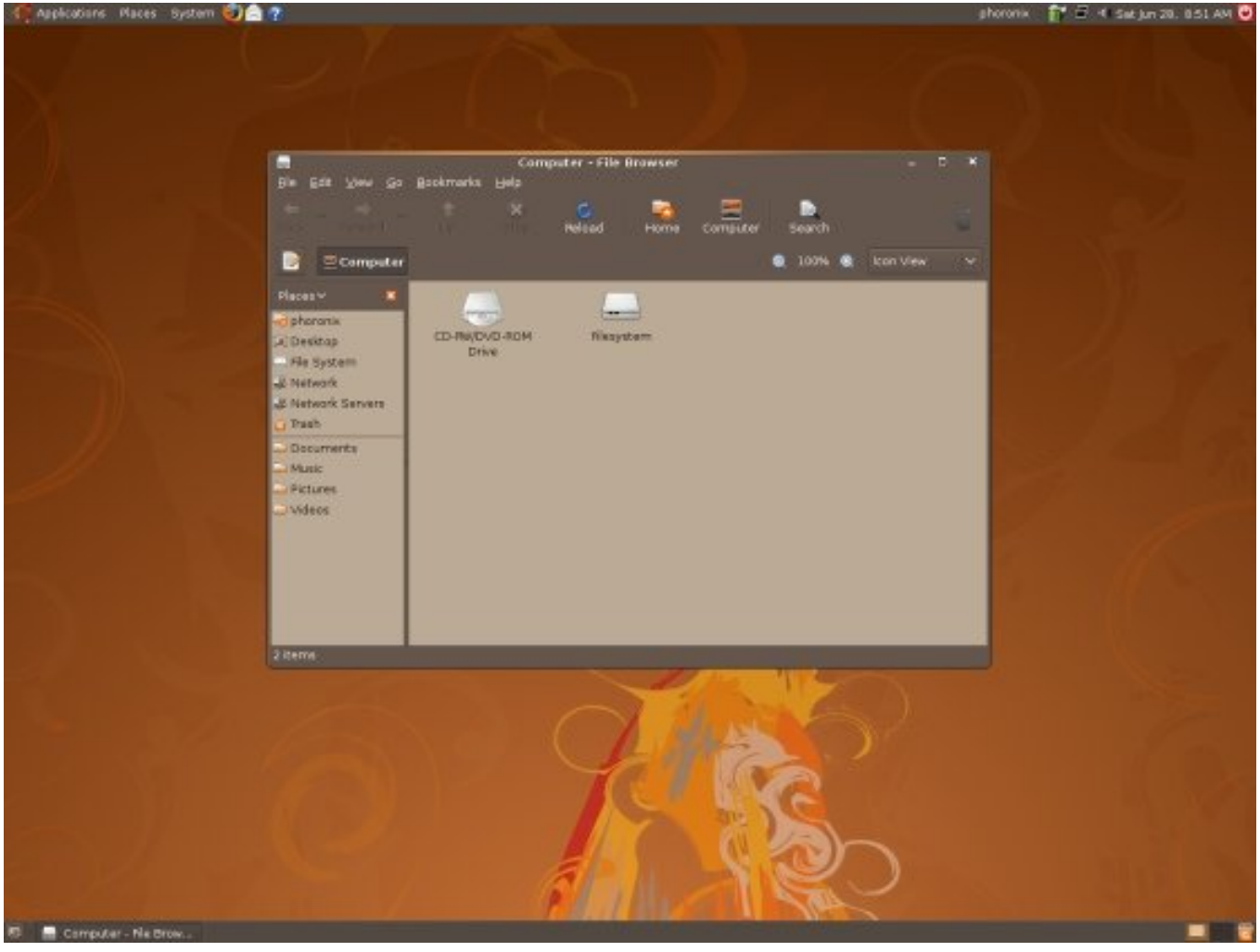
- This lecture explores the Linux operating system and its shell command-line interface.

- We need Linux for several reasons:
  - Linux gives us a command-line interface (CLI) to the operating system (and the file system), i.e., we can write code.
  - We can easily use a CLI remotely.
  - The software and/or the data we need may be on Linux.
  - Big, fast servers are likely to be running Linux.
  - There are some things that are better/faster to do in the Linux CLI than in R.
  - Linux is good for you.

Linux

- Many different distributions, but very similar user experience; we will work in Ubuntu.
- A desktop Linux GUI looks just like Windows or Mac, just less trendy.
- We will be working with the CLI rather than the GUI (and we will be working remotely).
- If you are working with a desktop Linux GUI, look for icon or menu item called “XTerm” or “Terminal” or “Terminal Emulator”.

Linux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Computer - File Brow...

Getting Linux

- Use the Ubuntu 18.04 desktop from FlexIT.
- `ssh` (or `ssh -X`) from there to a VM.
- See the "Computing Environments" document in the "Introduction" Topic Module.

The shell

- A command-line interface to the operating system.
  (Not entirely unlike the command-line in R)
- Communication is text-based: text commands in and text output out.
- A "terminal" program allows us to send commands to the shell and display the results. It is common to have several terminals open at once.
- Typing commands is writing code: we can record our actions (so we can repeat actions, adapt actions, document actions, share actions); we can express more complex actions; we can programmatically control our actions; we can work without a GUI (e.g., on a remote server).
- There are several shell programs; we will use `bash` (the Bourne-Again SHell).

Shell file system commands

`pwd`	print the current (working) directory.
`ls`	list files (in the current directory).
`mkdir`	make a new directory.
`cd`	change directory.
`cp`	copy a file (or directory).
`mv`	move a file (or directory).
`rm`	remove (delete) a file (or directory).
`rmdir`	remove (delete) a directory.
`df`	report file system disk space usage.

WARNING: `rm` does NOT ask for confirmation.

Linux file paths

- "directory" is the same as "folder".
- Can be just a file name (implies a file in the current directory).
- Can be a series of directory names, separated by `/`.
- Can start with `/`, in which case the path is absolute (starts from the "root" of the file system).
  Otherwise the path is relative to the current directory.
- `.` means the current directory.
- `..` means the parent directory.

Shell file system commands

Each shell command has options that control its action.

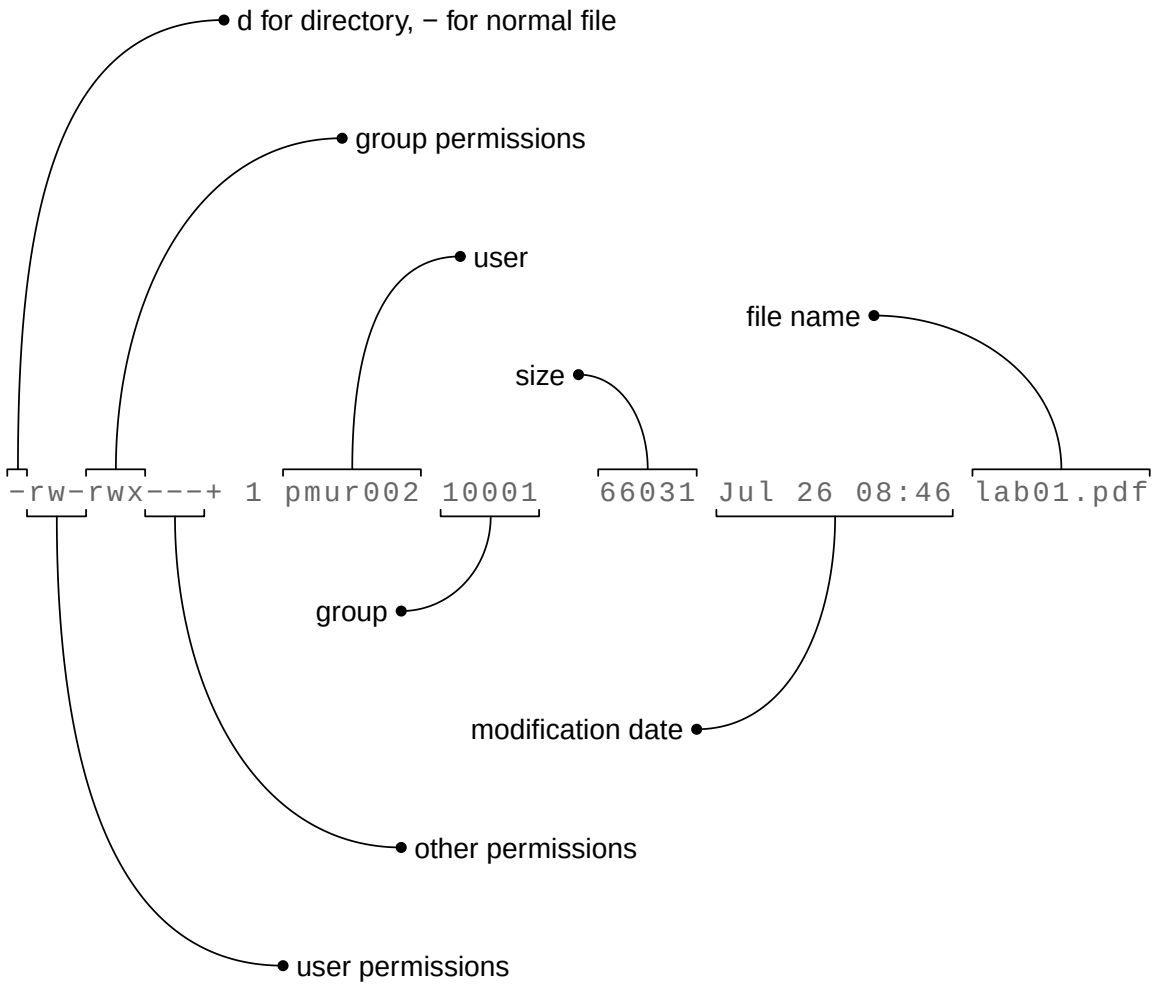
- The `man` command displays help information about a command.
- `ls -latr`
- `cp -ru`
- `rm -r`

Linux help pages

```
LS(1)                          User Commands                          LS(1)

NAME
       ls - list directory contents

SYNOPSIS
       ls [OPTION]... [FILE]...

DESCRIPTION
       List  information  about  the FILEs (the current directory by default).
       Sort entries alphabetically if none of -cftuvSUX nor --sort  is  speci-
       fied.

       Mandatory  arguments  to  long  options are mandatory for short options
       too.

       -a, --all
              do not ignore entries starting with .

       -A, --almost-all
              do not list implied . and ..
```

Press the space bar to show the next page, press the Enter key to show the next line, press the Q key to exit.

Linux file listings



Linux file permissions

- Three sets of `rwx` for user, group, and other.
- `r` means we can read the file.
- `w` means we can write to the file.
- `x` means we can run (execute) the file.
- For a directory, `r` means we can list the directory contents, `w` means we can create and remove files within the directory, `x` means we can enter the directory.
- `chmod` can be used to modify permissions.
- `chmod u+rwx`
- `chmod -w`

Viewing files in the shell

Every Linux distribution comes with a basic set of useful programs.

`echo`	Print a value on the screen.
`cat`	Print a file to the screen.
`head`	Print the first few lines of a file.
`tail`	Print the last few lines of a file.
`more`	Print a file one page/screen at a time.

Running programs in the shell

- In a GUI (like Windows), we are used to double-clicking on icons to open programs and documents.
- In a CLI, we run a program by typing its name.
- Lots of Linux programs run, produce output, then stop (similar to R function calls).
- Use `Ctrl-c` to kill a program.

Running programs in the shell

Some differences between running programs in Windows and running programs in the shell ...

- programs do not necessarily provide a GUI window, only a CLI.
- program input comes from the keyboard or a file and program output goes to a file or to the screen.
- both input and output are often just text.

Running programs in the shell

Compared to a single-user, local storage, Windows PC, Linux provides a ...

- Multi-user environment.
  - Use `who` to see who is logged on to the computer.
- Shared-resource environment.
  - Use `top` to see which programs and users are using which resources.

Running R in the shell

- Just type `R`
- The working directory defaults to the directory in which R started.
- The `source()` function becomes useful for running code in a `.R` file.
- Rscript can be used to run a file in "batch mode."

Processing R Markdown files in the shell

- `Rscript -e 'rmarkdown::render("myfile.Rmd")'`
- Use `bash` code chunks for shell commands

Editing files

- We should develop code by saving it in a text file (an R script file or an R markdown file).
- The shell can only receive and display text output (no mouse and no graphics).

- There are text editors that work in the shell (e.g., `vi`), but they can be awkward to use.
- If we work in the university-provided student storage, we can edit files on our local machine (e.g., using R Studio).

Viewing graphical output

- We will sometimes want to view graphical output from R (e.g., PDF files) or a processed R Markdown document (HTML file).
- The shell can only display text output.

- If we work in the university-provided student storage, we can view graphical output on our local machine (e.g., using Adobe Reader or a web browser).
- We can also view those files via `https://homeweb.auckland.ac.nz`

Resources

- Linux shell introduction
  `http://linuxcommand.org/index.php`
- Software Carpentry materials for UNIX shell (Sections 1, 2, and 3)
  `http://swcarpentry.github.io/shell-novice/`
- 'knitr' Options
  `https://yihui.name/knitr/options/`