GeoSciences *at* Edinburgh

LINUX Advanced Topics

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Session 4.1

LINUX Advanced Topics

- This section of the Introductory Computing Course will look at:
  - Scratch space
  - Controlling LINUX Processes
  - Joining commands together
  - Redirecting output to a file
  - Automating processes with a shell script
  - Programming, modelling, visualisation
  - High Performance Computing
  - The need to edit files
  - Editing on LINUX

Scratch Space

- Scratch space provides large amount of data storage for short-ish periods
- Just as you have space here:

  /home/yourusername
- So you also have space here:

  /scratch/yourusername
- There is no backup of this data, but it probably won't be deleted
- You can access 'scratch' from your M: drive via a 'shortcut' folder or connect it as a virtual PC drive:

  \\students.geos.ed.ac.uk\scratch\s1xxxx

LINUX Processes

Terminology:

- All applications in LINUX start one or more **processes**
- This happens in Windows too, but in LINUX it's easier to see how they work and you have far more control over the processes
- A knowledge of processes gives **you** flexibility of operation
- It also lets **you** keep the LINUX machines running smoothly and **fast**
- A **background process** is one which runs behind the scenes putting its output in a file having been spun off by the user
- A **batch process** also puts its output in a file, but takes its input from another file as a series of commands)

Controlling Processes

- Can start, stop, pause, change priority of all the processes that belong to you
- Why bother?
  - Because sometimes it's very useful to hide your model in the background (still working) while you leave the building.
  - Or have a web browser open on the relevant web help page as you try and understand the LINUX command you just learnt
  - In other words, **you** can control which of **your** processes are given priority (run faster)
  - Or kill off processes which have crashed or run amuck
- Allows more efficient multitasking - you can set the priorities of processes with the `renice` command so that unimportant tasks do not hog the servers processor power

Process-related Commands

- The **`ps`** command allows processes to be examined

  `ps -af`

  allows you to find out exactly what other people are up to!
- The **`kill`** command is vital for tidying up when things go wrong

  `kill -9 5226`

  unambiguously kills the process with PID=5226
- The PID (Process Id) is displayed using **`ps`**
- You can only kill your own processes !

Controlling Batch Processes

- Batch processes run single commands, sets of commands (scripts) or applications
- They cannot (easily) run applications which require graphical input
- Input is taken from a file as a series of commands
- Any output, which would ordinarily go to the screen, is written to a file
- They can be started automatically at any pre-defined time
- The **`at`** (simpler) and **`crontab`** (more complex) commands allows batch processes to be defined on LINUX
- **`atq`** shows what is queued, **`atrm`** removes a job and **`kill`** kills it if already running

Joining LINUX commands together

- Terminology: a **pipe** is a way of taking the **output** from one command and feeding it directly as **input** into another command
- A pipe is represented by the vertical bar on the bottom left of the keyboard: |
- For example:

```
who | grep '^s'
```

shows only the users beginning with the letter "s"

Saving output to a file

- Almost all the commands you used this morning sent their output to the screen
- Extending the concept of a pipe, you can easily redirect output of a command to a text file for future use
- For example,

  `grep -n 'Bruce' index.html > file.txt`

  Would output all lines from my web page containing the word 'Bruce'
- ***Pipes*** and ***redirection*** used together can give you powerful search and analysis tools for only a tiny bit of typing...

Shells and Shell Scripts

- LINUX commands are typed at a shell prompt eg. `bash$`
- The shell passes the command to the LINUX kernel for execution
- Different shells are available, offering different facilities eg.
  - customising the environment
  - define command aliases
  - edit and reissue previous commands
  - automatically complete the command line
- It is also possible to run a sequence of commands together into a ***shell script***

Shell Scripts

- This is a very simple bash shell script:

```
#!/bin/bash
echo "hello, $USER. I wish to list some of your files"
echo "Listing files in the current directory, $PWD"
ls  # list files
```

- This example is more complex:

```
#!/bin/bash
OPTIONS="Hello Quit"
select opt in $OPTIONS; do
    if [ "$opt" = "Quit" ]; then
         echo done
         exit
    elif [ "$opt" = "Hello" ]; then
         echo Hello World
    else
         clear
         echo bad option
    fi
done
```

Programming - Modelling - Visualisation

- Several programming environments are available for scientific data visualisation and modelling:
  - Python (free and open-source)
  - R (free and open-source)
  - MATLAB (licenced)
  - IDL (limited licenced; GDL free and open-source)
  - Java (free and open-source)
- These usually run on LINUX
- Research groups favour different environments based on existing code base and models
- Python is extensible, with MATPLOTLIB resembles MATLIB, and is used to customise tools like ArcGIS

High Performance Computing

- Running large models or processing large datasets can slow the GeoSciences servers for everyone
- Therefore use Eddie (ECDF Linux Compute Cluster)
- There are also Symmetric Multiprocessing (SMP) and Large Memory Systems
- If you just want to store large datasets use the Research Data Store
  - accessible from linux or windows
  - available to research students and GIS/EO taught students
- Further information from Edinburgh Compute and Data Facility

Using an Editor

- Editing involves modifying programs or data, as against word-processing which involves creating documents
- You may also need to prepare or modify data files as input to a program which undertakes analysis (eg. statistics package, GIS etc.)
- You don't want to use a word-processor because it will introduce *formatting characters*
- You could use a spreadsheet, but this introduces structure to your data
- An editor lets you get at the raw data

ASCII versus Binary files

- Generally:
  - ASCII files (or text files) are those which contain data you can understand
  - Binary files contain data which the computer understands
- Data files may be ASCII or binary, as can programs
- Binary files compress information into a more compact form
- You shouldn't try to directly print binary files
- Binary files are usually very specific to the software which created them (eg. Photoshop)
- Word-processing files are actually binary, because they contain hidden formatting information

Editing files

- PSPad is a powerful PC editor
- There is also another useful editor called TextPad (and WordPad and NotePad)
- PSPad does many things familiar from a word-processor, but also has advanced features such as search-and-replace across multiple files
- Slightly unusually, PSPad will allow you to edit binary files, but this is a dangerous operation

PSPad – Useful Facilities

- Opening multiple files, allocating them to tabs and reopening them when PSPad is next used
- Showing line numbers
- Wrapping / unwrapping of long lines in data and program files
- Find and replace over multiple files
- Differences between files
- Colour coding of program files
- PSPad can be run directly from your USB stick without installing on a machine

Text Editing on LINUX

- Preparing shell scripts, programming, configuring the system etc. all need text files to be edited
- Could use PSPad from a managed desktop PC to edit files on your network drive assuming this is attached to LINUX
- This is an indirect way of editing files
- LINUX and PC text files differ in the way they handle returns/end of line characters
- Thus you can easily get confused and wonder why things aren't working!
- Windows based PSPad can read and save files in either PC or UNIX format, take care which!

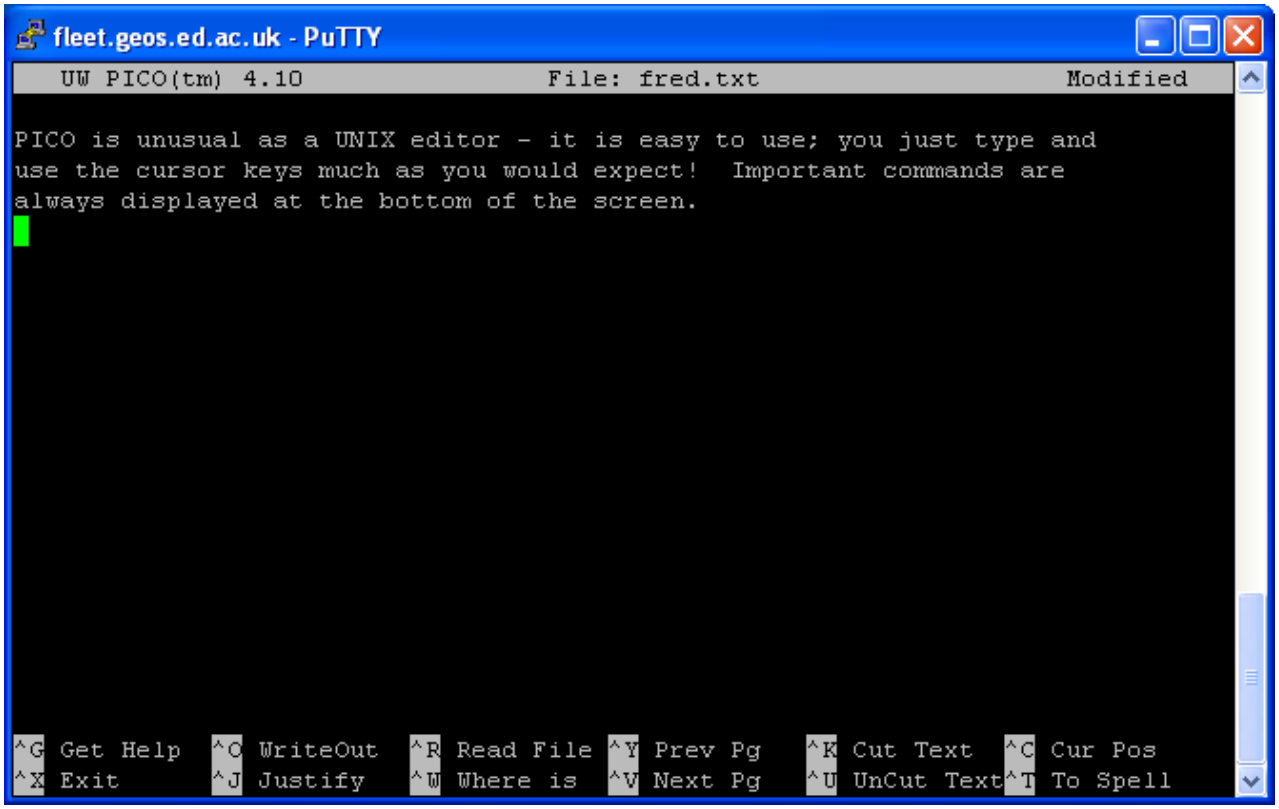
LINUX Editors

- There are many editors which run directly on LINUX
- Like cars some people get excitedly evangelical about their favourite editor and despise others!
- Some good choices:
  - pico (easy-to-use, widely available)
  - emacs (long established, v. sophisticated, but more difficult to use. Supports X-Windows)
- Don’t seem as friendly - use keyboard commands, but once you know these it is extremely fast to use
- Quicker that PSPad – less clicking – but only when you know what you're doing!
- Emacs is also available for the PC if you get to really love it

Pico

- A screen-based text editor
- Available on most LINUX systems
- Unusual for a LINUX editor it is easy to use!
- The default editor for the PINE mail system
- Written for this purpose by the University of Washington

More Pico

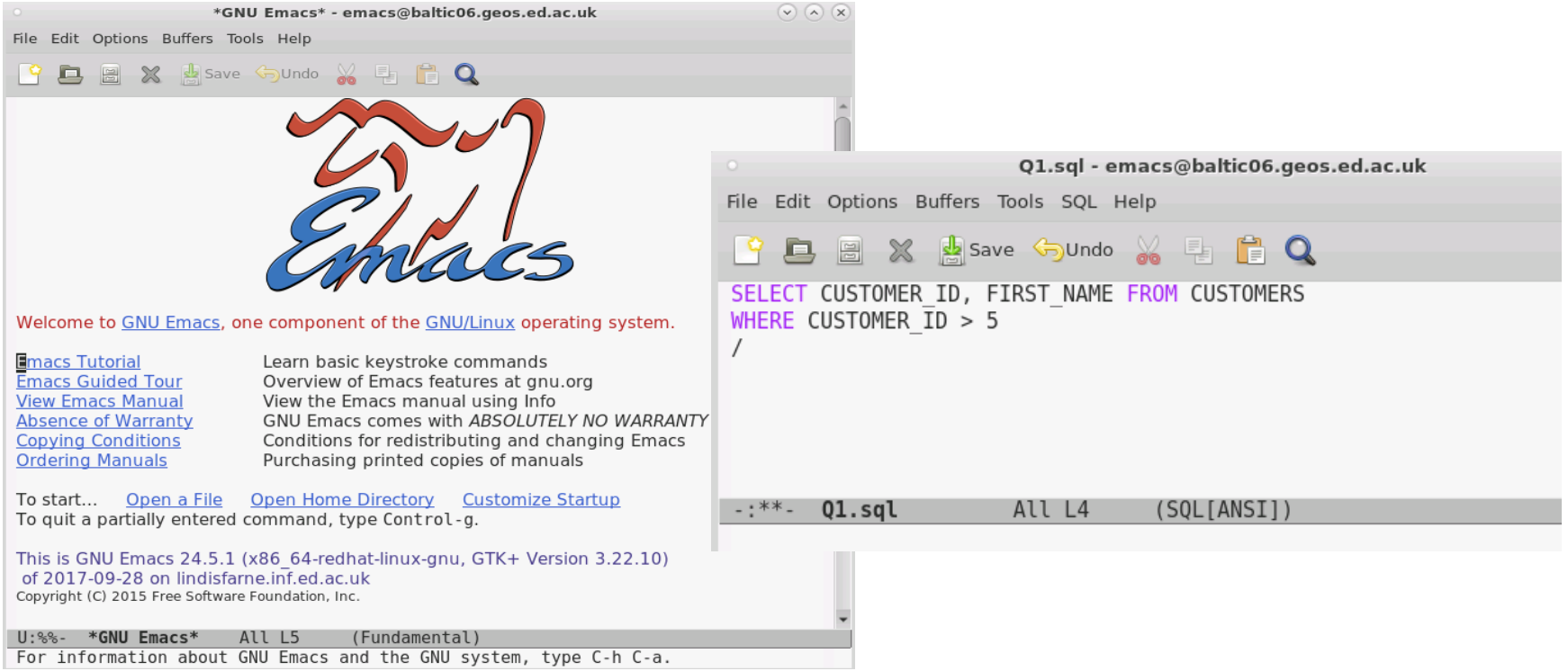


- Possible commands are displayed at the bottom of every screen
- Straightforward help info is easily accessible

Emacs

- There are graphical and command-based versions
- Been around a while - developed in 1976 as a set of macros for the DEC's 1962 TECO editor ☺
- Can be more difficult to use, but lots of facilities
- Over 10,000 built-in commands
- We will use this in the core GIS courses *Spatial Modelling and Analysis* (for writing database queries) and *Technological Infrastructures for GIS* (for python programming)
- In remote desktop / xrdp, give the command **emacs**

More emacs



- Commands are on menus
- Features syntax-highlighting – very useful for programming
- Tutorials and manuals are available