

Introduction to the Command line

- in this lecture series we will be using GNU/Linux to develop our understanding of systems programming in C

- one of the beauties of GNU/Linux is that you can do all your development from the command line or alternatively from a graphical interface
 - on GNU/Linux the command line interface is *extremely* powerful
 - once learnt it will last you a lifetime
 - different GUI's and IDE's come and go

GNU/Linux at Glamorgan

- you can create yourself a username at Glamorgan by [clicking here](http://mcgreg.comp.glam.ac.uk/login.html)
(`http://mcgreg.comp.glam.ac.uk/login.html`)
 - the same link can be used to change your password, or reset your password if you forget it

- all second floor laboratories are dual boot and will boot into Fedora Core or Windows

- you can also access `mcgreg.comp.glam.ac.uk` (the GNU/Linux fileservers) via `ssh` on the command line in Fedora Core or

- alternatively via `putty` under Windows
 - both programs can give you remote command line access to the GNU/Linux server

GNU/Linux at Glamorgan

- hence you *should* be able to use `putty` under Windows in J1 (24 hour access lab) and also from halls of residence

Introduction to the Command line

- make sure that you have a working username and password under GNU/Linux and login to the server or the Fedora Core client
- if you are using Windows, either reboot the machine and start Fedora Core or download `putty` and remotely log into `mcgreg.comp.glam.ac.uk`
- you can also use the `telnet` program under Windows to access `mcgreg.comp.glam.ac.uk`
 - if you are using `telnet` or `putty` maximise the window
- if you are using Fedora Core then open up a `terminal` window and maximise it

Introduction to the command line

- the first command to be aware of is `man`. To examine what this does type:
- ```
$ man man
```
- when you have read enough, type 'q'

## Introduction to the command line

- to find out whether a command exists for a particular function, type

```
$ man -k directory
```

- this command tells you all the commands which are associated with directories

- you can filter the search by:

```
$ man -k directory | grep list
```

# Critical general purpose command line programs

- `cd` change directory
- `pwd` print working directory
- `cp` copy a file
- `mv` rename a file (move)
- `cat` display contents of a file

## Critical general purpose command line programs

- `less` display contents of a file, a page at a time
- `grep` print lines matching a pattern
- all programs can be combined using the pipe operator
- for example

```
$ man -k directory | less
```



## Critical development command line programs

- gcc the C GNU compiler
- gdb the GNU debugger
- emacs the GNU editor

## Minimal introduction to emacs

- to start editing the file `tiny.c` with `emacs` editor type:

- ```
$ emacs tiny.c
```

- critical key commands
 - this editor can be controlled from the keyboard (without the mouse)
- use cursor keys, page up, page down, to move around the text

Minimal introduction to emacs

- in this section of the notes the notation ^C means press the control key and then press the C key, finally release both keys
- type ^X^S to save your file
- type ^X^C to quit emacs

Creating a simple C program under GNU/Linux

- using emacs create the following file (called `tiny.c`)
- the contents of this `tiny.c` should be as follows

```
#include <stdio.h>

main()
{
    int i;

    for (i=1; i<=12; i++) {
        printf("%d x 8 = %d\n", i, i*8);
    }
}
```

Minimal introduction to GCC

- gcc is the GNU C compiler
- now exit emacs and compiler `tiny.c`, you can compile and link `tiny.c` like this:

```
$ gcc -g tiny.c
```

- this generates a file `a.out` which can be run, from the command line by typing:

```
$ ./a.out
```

Minimal introduction to GDB

- gdb is the GNU debugger, which can be useful to both
 - debug your program
 - understand how a program works

Minimal introduction to GDB

- for example, suppose we wanted to understand which lines of code are executed in your `tiny.c` program, you could

```
$ gdb a.out
GNU gdb 6.4.90-debian
Copyright (C) 2006 Free Software Foundation, Inc.
GDB is free software, etc
(gdb) break main
Breakpoint 1 at 0x8048365: file tiny.c, line 7.
(gdb) run
```

Minimal introduction to GDB

```
Breakpoint 1, main () at tiny.c:7
7      for (i=1; i<=12; i++) {
(gdb) step
8      printf("%d x 8 = %d\n", i, i*8);
(gdb) step
1 x 8 = 8
7      for (i=1; i<=12; i++) {
(gdb) step
8      printf("%d x 8 = %d\n", i, i*8);
(gdb) print i
$1 = 2
(gdb) step
2 x 8 = 16
7      for (i=1; i<=12; i++) {
(gdb) quit
The program is running.  Exit anyway? (y or n) y
```


Extending tiny.c to use a function

- use emacs to modify the `tiny.c` program (to include a mistake)

```
#include <stdio.h>

int mult (int i)
{
    return i*9;
}

main()
{
    int i;

    for (i=1; i<=12; i++) {
        printf("%d x 8 = %d\n", i, mult(i));
    }
}
```

Extending tiny.c to use a function

- now recompile the program by:

- ```
$ gcc -g tiny.c
```

## Extending tiny.c to use a function

- and run the program, as before

```
$./a.out
1 x 8 = 9
2 x 8 = 18
3 x 8 = 27
4 x 8 = 36
5 x 8 = 45
6 x 8 = 54
7 x 8 = 63
8 x 8 = 72
9 x 8 = 81
10 x 8 = 90
11 x 8 = 99
12 x 8 = 108
```

## Extending tiny.c to use a function

- we can single step the program to find out where the mistake occurred

```
$ gdb a.out
GNU gdb 6.4.90-debian
Copyright (C) 2006 Free Software Foundation, Inc.
GDB is free software, etc
(gdb) break main
Breakpoint 1 at 0x8048365: file tiny.c, line 7.
(gdb) run
```

## Extending tiny.c to use a function

```
(gdb) run
Starting program: a.out

Breakpoint 1, main () at tiny2.c:12
12 for (i=1; i<=12; i++) {
(gdb) step
13 printf("%d x 8 = %d\n", i, mult(i));
(gdb) step
mult (i=1) at tiny2.c:5
5 return i*9;
(gdb) fin
Run till exit from #0 mult (i=1) at tiny2.c:5
0x08048388 in main () at tiny2.c:13
13 printf("%d x 8 = %d\n", i, mult(i));
Value returned is $1 = 9
```

at this point we see our mistake, the function has returned 9

## Extending tiny.c to use a function

- we can see this again if we continue around the `for` loop

```
(gdb) step
1 x 8 = 9
12 for (i=1; i<=12; i++) {
(gdb) step
13 printf("%d x 8 = %d\n", i, mult(i));
(gdb) step
mult (i=2) at tiny2.c:5
5 return i*9;
```

## Extending tiny.c to use a function

```
(gdb) print i
$1 = 2
(gdb) up
#1 0x08048388 in main () at tiny2.c:13
13 printf("%d x 8 = %d\n", i, mult(i));
(gdb) print i
$2 = 2
(gdb) down
#0 mult (i=2) at tiny2.c:5
5 return i*9;
```

## Using gdb from within emacs

- you can run `gdb` from within `emacs` and have `emacs` perform source file correspondence
- *if* you wish to do this then it would be sensible to create a file `.gdbinit` and populate it with

```

this file is the gdb start up script and
you can place any gdb commands in here

break main
run
```

- this file is read by `gdb` when `gdb` is executed



## Using gdb from within emacs

- now at the command line, you can type:

```
$ emacs
```

- now type: **<alt>xgdb<enter>** within emacs
- now you can enter the gdb commands **step next print fin** and **quit** and emacs will track the source file and line number in an alternate window

# Tutorial

- work through these lecture notes, trying each example in turn