

Introduction to the command line

- in this module we will examine:
 - tools necessary to develop game engines: `gdb`, `emacs` and friends
- examine how one can integrate Python into a game engine `doom3`
- examine and extend a small physics game engine and expose its API to Python
- also revisit C and familiarise ourselves with pointers and indirect function calls
- learn how to debug shared libraries and exploit remote debugging

Introduction to the Command line

- in this lecture series we will be using GNU/Linux to develop our understanding of 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 South Wales

- you can create yourself a username at South Wales 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 machines in J109 are triple boot (will boot into GNU/Linux, OSX or Windows) we will be using GNU/Linux

Introduction to the Command line

- make sure that you have a working username and password under GNU/Linux and boot up the imac into Linux
- and login
- and open up a terminal window
- adjust the window font size so it looks good and rearrange the window and this browser so both fit on the same screen without overlaps

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

## File organisation

- please try and keep your \$HOME directories tidy
  - it is good practice to create separate directories for different courses and tutorials
- for example, here we might want to use the following commands:
- ```
$ mkdir -p cs3s609/tutorial1  
$ cd cs3s609/tutorial1
```
- (before moving onto the next slide)

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  $\text{^C}$  means press the control key and then press the C key, finally release both keys
- type  $\text{^X^S}$  to save your file
- type  $\text{^X^C}$  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) next
8      printf(``%d x 8 = %d\n'', i, i*8);
(gdb) next
1 x 8 = 8
7      for (i=1; i<=12; i++) {
(gdb) next
8      printf(``%d x 8 = %d\n'', i, i*8);
(gdb) print i
$1 = 2
(gdb) next
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`

## Using gdb from within emacs

- at this point make sure your emacs is a large window
- now type: **<alt>xgdb<enter>** within emacs
- now type: **<alt>xgdb-many-windows<enter>**
- now you can enter the gdb commands **step next print fin** and **quit** and emacs will track the source file, line number, local variables, call frames, output in alternate windows
  - do not resize emacs after this though

# Tutorial

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

## References/Further reading

- [Introduction to the command line](http://shop.fsf.org/product/Introduction_to_Command_Line) `<http://shop.fsf.org/product/Introduction_to_Command_Line>` [\(pdf\)](#)  
`<http://en.flossmanuals.net/CommandLineIntro/FM_16Apr09.pdf>`
- [gdb documentation](http://sourceware.org/gdb/current/onlinedocs/gdb) `<http://sourceware.org/gdb/current/onlinedocs/gdb>`