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`⟩
  - 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 `^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) 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 though 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⟩ (pdf) ⟨http://en.flossmanuals.net/CommandLineIntro/FM_16Apr09.pdf⟩

- gdb documentation ⟨http://sourceware.org/gdb/current/onlinedocs/gdb⟩