

Programming Proverbs

- 4. “Be aware of other approaches.”
- Henry F. Ledgard, “Programming Proverbs: Principles of Good Programming with Numerous Examples to Improve Programming Style and Proficiency”, (Hayden Computer Programming Series), Hayden Book Company, 1st edition, ISBN-13: 978-0810455221, December 1975.

Know your tools

- "a bad workman blames his tools",
Cambridge Idioms Dictionary
- we will examine:
 - emacs, etags, grep, diff, patch, gcc, gm2, cvs, gdb, svn
- although in this lecture we will only cover emacs and gdb
 - and revise our knowledge of C pointers

For the GNU/Linux game developer GDB is the BFG

- get to know this tool!

emacs

- GNU Emacs is an extensible, customisable text editor-and more
- at its core is an interpreter for Emacs Lisp, a dialect of the Lisp programming language with extensions to support text editing
- features of GNU Emacs include:
 - content-sensitive editing modes
 - highly customisable, using Emacs Lisp code or a graphical interface
 - can run a shell, ssh session, read news, read mail, run gdb
 - all the above are editing sessions
 - learn how to navigate it once, use it in a multitude of ways

Minimal number of key commands for emacs

- deliberately kept short!
- \hat{c} means control key is pressed and kept down while the `c` key is also pressed. After which both are released.
- `M-x` means press the meta key (the `<alt>` key) and then press the `x` key and then release both.
- `M-x` can also be achieved by pressing the `<esc>` key, releasing it and then pressing `x` and releasing it.
- choose which ever seems most natural

emacs keys

Keys	meaning
=====	
<code>^x^c</code>	exit emacs
<code>^x2</code>	split screens horizontally into two
<code>^xo</code>	move cursor into other window
<code>^x^f</code>	load in a new file
<code>^x^s</code>	save current buffer
<code>^xs</code>	save all buffers
<code>^s</code>	search forward
<code>^r</code>	search reverse
<code>^k</code>	cut rest of line into kill buffer
<code>^y</code>	yank the last kill buffer (paste it into the current location)
<code>^<space></code>	mark the current position
<code>^w</code>	kill all text between current position and last marked position
<code>M-x</code>	move to the execute-extended-command line
<code>^g</code>	stop emacs from doing something
<code>^xb</code>	change buffer (press tab to see all available buffers)

emacs function keys

- | | |
|-----|-------------------------|
| f5 | debug doom3 |
| f8 | goto next compile error |
| f11 | full screen (toggle) |
| f12 | recompile doom3 |
- can be customised by changing `$HOME/.emacs`

Further emacs information

- [emacs homepage](http://www.gnu.org/software/emacs) `<http://www.gnu.org/software/emacs>`
- the best way to learn how to use emacs is by reading the built-in documentation
- to do this, start emacs and then use the commands:
 - Interactive beginners' tutorial - to start this from within emacs, type `^ht`
 - this is an extremely well written tutorial - well worth the reading effort
 - List of Frequently Asked Questions, type `^h^f`

C Pointers and arrays revisited

- a pointer is a variable that contains an address of a (normally different) variable
- arrays and pointers are closely related in C
- we can declare an array of integers by:

```
int a[10];
```

- and we can declare a pointer to an integer, by:

```
int *b;
```

Initialising a pointer

- we can make `b` point to the start of the array, by:

```
int *b = (int *)&a;
```

- to set the first element of the array to 999 we can either use the pointer or the array variable

Initialising a pointer

```
#include <stdio.h>

int main ()
{
    int a[10];
    int *b = (int *)&a;

    a[0] = 111;
    printf("the first element of the array has been set to %d\n",
           a[0]);
    *b = 999;
    printf("the value of the first element is now %d\n", a[0]);
    return 0;
}
```

Initialising a pointer

- we can assign 777 to the second element of the array by the following code:

```
#include <stdio.h>

int main ()
{
    int a[10];
    int *b = (int *)&a;

    b++;
    *b = 777;
    printf("the second element of the array has been set to %d\n",
           a[1]);
    return 0;
}
```

- notice that we moved to the second element on the array by: b++

Initialising a pointer

- we could have also written the code like this:

```
#include <stdio.h>

int main ()
{
    int a[10];
    int *b = (int *)&a[1];

    *b = 777;
    printf("the second element of the array has been set to %d\n",
           a[1]);
    return 0;
}
```

Initialising a pointer

■ or like this:

```
#include <stdio.h>

int main ()
{
    int a[10];
    int *b = ((int *)&a)+1;

    *b = 777;
    printf("the second element of the array has been set to %d\n",
           a[1]);
    return 0;
}
```

Initialising a pointer

- the addition of 1 to a pointer means increment the address value in the pointer variable by: `sizeof(*b)` bytes
- avoid arithmetic on pointers if at all possible

Interchanging pointers and arrays

- we can also set the third element of the array to 444 by:

```
#include <stdio.h>

int main ()
{
    int a[10];
    int *b = (int *)&a;

    b[3] = 444;
    printf("the second element of the array has been set to %d\n",
           b[3]);
    return 0;
}
```

- notice how we are treating b as an array, although we declared it as a pointer

Interchanging pointers and arrays

- clearer than adding, 3, to a pointer, and the same code is generated by the compiler
- use the debugger to print out values, or set values
- compile the previous example using
- ```
$ gcc -g pointer2.c
```
- then we can run the debugger as follows

## Interchanging pointers and arrays

```
$ gdb ./a.out
GNU gdb 6.4.90-debian
Copyright etc...
(gdb) break main
Breakpoint 1 at 0x400480: file pointer2.c, line 6.
(gdb) run
Starting program: /home/gaius/text/Glamorgan/gaius/c/a.out
Breakpoint 1, main () at pointer2.c:6
6 int *b = (int *)&a;
(gdb) step
8 b[3] = 444;
(gdb) ptype b
type = int *
(gdb) step
9 printf("the second element of the array has been set to %d\n",
step
the second element of the array has been set to 444
11 }
```

## Interchanging pointers and arrays

```
(gdb) set *b=999
(gdb) print b[0]
$2 = 999
(gdb) print b[3]
$3 = 444
(gdb) set *(b+3)=777
(gdb) print b[3]
$4 = 777
(gdb) quit
```

## structs and pointers

- recall a struct can be define a linked list like this:

```
struct list {
 struct list *right;
 struct list *left;
 char ch;
}
```

- here we declare a list structure which has 3 fields
  - right, left, and ch
  - right and left are also pointers to a list structure and ch is a character

## Initialising a pointer to a struct

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>

struct list {
 struct list *right;
 struct list *left;
 char ch;
};

int main ()
{
 struct list *h = (struct list *)malloc (sizeof (struct list));

 h->right = NULL;
 h->left = NULL;
 h->ch = '\0';

 return 0;
}
```

## prototype for malloc

- ```
extern void *malloc (unsigned int nBytes);
```
- which means the function `malloc` takes one parameter, the number of bytes requested
 - and returns an address to the start of a memory block which can be used to contain `nBytes` of information
- remember a generic pointer can be defined by the construct `void *`

Implementing a program to create a linked list of characters

```
#include <stdlib.h>
#include <stdio.h>
#include <string.h>

const char *myString = "hello world";

struct list {
    struct list *left;
    struct list *right;
    char        ch;
};

int main ()
{
    /* unfinished */

    return 0;
}
```

Implementing a program to create a linked list of characters

- fragment of implementation




```
struct list *head = NULL;

/* need to complete function add */

int main ()
{
    int n = strlen (myString);
    int i;

    for (i=0; i<n; i++) {
        add(a[i]);
    }
    return 0;
}
```

Implementing function add (which contains one deliberate mistake)

```
void add (char ch)
{
    struct list *e = (struct list *)malloc (sizeof (struct list));
    if (e == NULL) {
        perror("trying to add an element to the list");
        exit(1);
    }
    if (head == NULL) {
        head = e;
        e->right = e;
        e->left = e;
        e->ch = ch;
    }
    else {
        /* add e to the end of the list */
        e->right = head;
        e->left = head->left;
        head->left->right = e;
        head->left = e;
    }
}
```

Function main

```
int main ()
{
    int n = strlen (myString);
    struct list *f;
    int i;

    for (i=0; i<n; i++) {
        add(myString[i]);
    }
    if (head != NULL) {
        f = head;
        do {
            printf("char %c\n", f->ch);
            f = f->right;
        } while (f != head);
    }
    return 0;
}
```

Tutorial

- firstly use the debugger and find the bug in `add`

- secondly can you rewrite functions `add` and `main` so that you always keep a dummy head element and therefore you can reduce the `head==NULL` tests
 - the lines of code will reduce and there will be no need for an `else` statement