

CSC 4356 / ME 4573 Interactive Computer Graphics

C Language Refresher

C

All of you are programmers.

Few of you are C programmers.

These notes *briefly* list those aspects of C that may differ from what you already know.

See [Wikibooks](#) or [K&R](#) for more.

Variables and Types

C is a *statically*-typed, *imperative* language. Variables and their types must be declared before use.

```
double pi = 3.14159265358979;  
float x = 0.5;  
char c = 'a';  
int a = 42;  
int b;
```

The values of variables change, but not the types.

```
a = a * 10;  
b = a + 1;
```

Structure and Array Types

Structures are groups of values behaving as a single variable.

```
struct city
{
    int    population;
    float  latitude;
    float  longitude;
};
```

Arrays are contiguous blocks of values, all of the same type.

```
int n[10];
struct city capitals[50];
```

Pointer

A C *pointer* is an address in RAM.

```
int i  = 10;    // i is a normal integer variable.  
int *p = &i;    // p refers to the location of i.
```

The & operator gives “the address of” a variable

```
i  = 42;  
*p = 42;
```

The * operator gives “the variable at” an address.

Pointers

A C *string* is a pointer to a zero-terminated array of chars.

```
char *filename = "teapot.obj"
```

Pointers and arrays are interchangeable.

```
int a[10];  
int *p = a;  
  
a[5] = 12;  
p[5] = 12;
```

Functions

Functions are declared with arguments and return type.

```
int average(int a, int b)
{
    return (a + b) / 2;
}
```

Calling this function...

```
x = average(2, 8);
```

Conditionals

```
if (value == 0)
{
    answer = "false";
}
else
{
    answer = "true";
}
```

Remember that *assignment* uses =, while *equality* testing uses ==.

Looping

For-loop syntax includes initialization; test; and step.

```
int n = 0;
int i;

for (i = 0; i < 10; i++)
{
    n = n + i;
}
```

The Main Function

All C programs begin execution with the main function. It receives command line arguments as an array of strings.

```
int main(int argc, char *argv[])  
{  
    // ...  
    return 0;  
}
```

It returns zero to indicate success.

Command Line Arguments

For example, this command line...

```
./myprogram teapot.obj 32
```

... invokes main with these arguments:

argc = 3 argv =	0	"/myprogram"
	1	"teapot.obj"
	2	"32"

Function Declaration

A C function must be *declared* before it may be *used*.

```
int average(int a, int b);

int compute()
{
    return average(2, 8);
}

int average(int a, int b)
{
    return (a + b) / 2;
}
```

However, function *definition* counts as *declaration*.

```
int average(int a, int b)
{
    return (a + b) / 2;
}

int compute()
{
    return average(2, 8);
}
```

For this reason, C programs are often structured in a bottom-up fashion, with main at the very end.

Declaration becomes necessary when code is *defined* in one module...

```
int average(int a, int b)
{
    return (a + b) / 2;
}
```

... and *used* in another module.

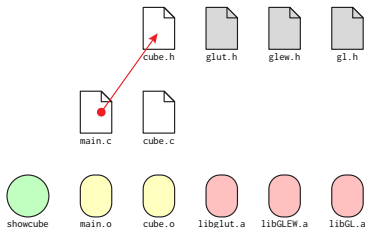
```
int average(int a, int b);

int compute()
{
    return average(2, 8);
}
```

This declaration is usually handled by a header.

```
#include "average.h"

int compute()
{
    return average(2, 8);
}
```



Recall the relationship discussed in the course notes on Project Management.

Memory Management

The C library provides *manual* memory management.

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

Allocate with malloc.

```
int *p;  
p = (int *) malloc(10 * sizeof (int));
```

And release with free.

```
free(p);
```


These two functions both allocate 10 integers.

```
void func()
{
    int a[10];

    // ...
}
```

```
void func()
{
    int *p;
    p = (int *) malloc(10 * sizeof (int));
    // ...
    free(p);
}
```

- On the stack.
- Auto-free.
- Static size.
- On the heap.
- Manually free.
- Dynamic size.

Beware sizeof!



`sizeof (a) == 10 * sizeof (int)`



`sizeof (p) == sizeof (int *)`

`sizeof (*p) == sizeof (int)`

Basic Output

The `printf` function performs basic formatted output.

```
char *s = "World";  
int   x = 42;  
  
printf("Hello, %s!\n", s);  
printf("The answer is %d.\n", x);
```

This produces:

```
Hello, World!  
The answer is 42.
```

File I/O

Access to files on disk is provided via *file pointers*.

```
#include <stdio.h>  
FILE *fp;
```

These may be opened for either reading or writing.

```
fp = fopen("myfile.txt", "r"); // or  
fp = fopen("myfile.txt", "w");
```

Be sure to close the file when finished.

```
fclose(fp);
```

Text File I/O

`fprintf` performs basic file output just like `printf`.

```
int x = 42;  
fprintf(fp, "The answer is %d.\n", x);
```

`fscanf` does just the opposite, basic file input.

```
int x;  
fscanf(fp, "%d", &x);
```

Note, `fscanf` takes a *pointer* to the variable taking the value.

Binary File I/O

`fwrite` and `fread` perform output and input of *binary* data.

```
FILE *fp = fopen("output.dat", "wb");
```

For example, to write five 32-bit integers in $5 \times 4 = 20$ bytes.

```
int n[5] = { 1, 2, 3, 4, 5 };  
fwrite(n, sizeof (int), 5, fp);
```

To read the same...

```
int n[5];  
fread(n, sizeof (int), 5, fp);
```

Mathematics

The C math library provides floating point functions, including trigonometry.

```
#include <math.h>

double radius = sqrt(pow(x, 2.0) + pow(y, 2.0));
double angle  = atan2(y, x);

x = cos(angle) * radius;
y = sin(angle) * radius;
```