COMP1511 - Programming Fundamentals

Week 1 - Lecture 2

What did we learn last lecture?

Introductions

- Course Administration
- Do you know where to find help? (Course website and forum!)
- Tips on how to do well in Programming

A first look at programming

- A brief look at computers and history
- Our very first C program . . .
- . . . Running in Linux!

What are we covering today?

Variables

- Variables and how we store information
- Some basic maths in code

Conditionals and Branching Code

- Conditionals - Running code based on questions and answers
- The **'if'** statement

Live Lecture Code

A link for you to read the code I write in lectures

- http://web.cse.unsw.edu.au/~marcchee
- This link is the actual directory where the lecture code is written
- Every time Marc saves the code file, it will appear there!
- Today's code will be in:
- http://web.cse.unsw.edu.au/~marcchee/lecture02/

A brief recap

```c
// Demo Program showing output
// Marc Chee, September 2020

#include <stdio.h>

int main(void) {
    printf("Hello World.\n");
    return 0;
}
```

How does a computer remember things?

Ones and Zeros

- Computer memory is literally a big pile of on-off switches
- We call these **bits**
- We often collect these together into bunches of 8 bits
- We call these **bytes**

Bits and Bytes

- We are going to be working with chunks of memory made up of specific sizes
- You may have heard of things like 32bit and 64bit systems

Variables

A Variable is . . .

- Our way of asking the computer to remember something for us
- Called a "variable" because it can change its value
- A certain number of bits that we use to represent something
- Made with a specific purpose in mind

We’re going to start out with two types of number variables:

- **int** - integer, a whole number (eg: 0,1,2,3)
- **double** - floating point number (eg: 3.14159, 8.534, 7.11)

Naming your Variables

Remember . . . Half our coding is for people!

- Names are a quick description of what the variable is
  - Eg: “answer” and “diameter”
  - Rather than “a” and “b”
- We always use lower case letters to start our variable names
- C is case sensitive:
  - “ansWer” and “answer” are two different variables
- C also reserves some words
  - “return”, “int” and “double” can’t be used as variable names
- Multiple words
  - We can split words with underscores: "long_answer" or capitals: "shortAnswer"

int

Integer

- A whole number, with no fractions or decimals
- Most commonly uses 32 bits (which is also 4 bytes)
- This gives us exactly 2^{32} different possible values
- The maximum is very large, but it's not infinite!
- Exact ranges from -2147483648 (-2^{31}) to 2147483647 ($2^{31} - 1$)

double

A double-sized floating point number

- A decimal value - "floating point" means the point can be anywhere in the number
  - Eg: 10.567 or 105.67 (the points are in different places in the same digits)
- It’s called "double" because it’s usually 64 bits, hence the double size of our integers

Code for Variables

```
int main (void) {
    // Declaring a variable
    int answer;
    // Initialising the variable
    answer = 42;
    // Give the variable a different value
    answer = 7;

    // we can also Declare and Initialise together
     int answer_two = 88;
}
```

Printing Variables

printf

- Not just for specific messages we type in advance
- We can also print variables to our display

```
// printing a variable
int number = 7;
printf("My number is %d\n", number);
```

- `%d` - where in the output you'd like to put an int
- After the comma, you put the name of the variable you want to write

Printing more variables

printf with multiple variables

```
// print two variables
int first = 5;
int second = 10;
printf("First is %d and second is %d\n", first, second);
```

The variables will match the symbols in the same order as they appear

Printing different types of variables

`%d` is for ints, `%lf` is for doubles

```
// print an int and a double
int diameter = 5;
double pi = 3.14159;
printf("Diameter is %d, pi is , %lf\n", diameter, pi);
```

The **`%d`** and **`%lf`** are symbols that are part of printf

- **`%d`** stands for “decimal integer”
- **`%lf`** stands for “long floating point number” (a double)

Reading Input into Variables

scanf

Reads input from the user in the same format as printf

The `&` symbol that tells scanf where the variable is (more details later in term)

```
// reading an integer
int input;
printf("Please type in a number: ");
scanf("%d", &input);

// reading a double
double input_double;
printf("Please type in a decimal point number: ");
scanf("%lf", &input_double);
```

Constants

Constants are like variables, only they never change

Can't call it a variable if it isn't . . . variable

Sometimes we will use fixed numbers using a special command, **`#define`**

We name them in all caps so that we remember that they're not variables

```
// Variables demo
// Marc Chee, February 2019

#include <stdio.h>

#define PI 3.14159265359
#define SPEED_OF_LIGHT 299792458.0

int main (void) { ...
```

Maths

Numbers and Arithmetic

A lot of arithmetic operations will look very familiar in C

- `+,-,*,/`
- These will happen in their normal mathematical order
- We can also use brackets to force precedence

```c
// some basic maths
int x = 5;
int y = 10;
int result;
result = (x + y) * x;
printf("My maths comes out to: %d\n", result);
```

In more detail…

There are a lot of little details with the way variables are set up!

- These next three slides are not generally needed to use variables
- But they are some interesting and possibly dangerous side effects of how they're built

int issues

Some things to look out for

- **Overflow** and **Underflow**
- If we add two large ints together, we might go over the maximum value, which will actually roll around to the minimum value and possibly end up negative (trivia: Look up Ariane 5 explosion, a simple error like this caused a rather large problem)
- ints might not always be 32 bits . . . dependent on Operating System

double issues

Doubles also have a few things to think about . . .

- No such thing as infinite precision
- We can’t precisely encode a simple number like ⅓
- If we divide 1.0 by 3.0, we'll get an approximation of ⅓
- The effect of approximation can compound the more you use them

Division and Variable types

Division does some interesting things in C

- If either numbers in the division are **double**s, the result will be a **double**
- If both numbers are **int**s, the result will be an **int**
  - Eg: 3/2 will not return 1.5, because ints are only whole numbers
- **int**s will always drop whatever fraction exists, they won't round nicely
  - 5/3 will result in 1
- **%** is called **Modulus**. It will give us the remainder from a division between integers
  - Eg: 5 % 3 will result in 2 (3 goes into 5 once, with 2 left over)

Break Time

We'll take 5 minutes here before launching into some more C

What's in our code?

- A series of instructions
- Some are: Store this information (using variables)
- Some are: Perform this task
- Usually these will be performed in order from top to bottom
- It's a little bit like a cooking recipe!

Some More Linux

File operations on the command line

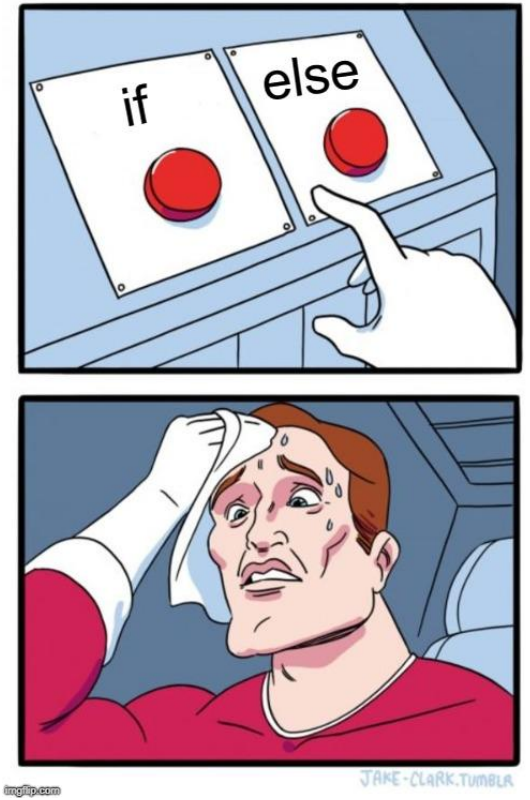
- **`cp` *`source destination`*** - copy
- **`mv` *`source destination`*** - move (can also be used to rename)
- **`rm` *`filename`*** - remove a file (delete)

The **`-r`** tag can be added to **`cp`** or **`rm`** to recursively go through a directory and perform the command on all the files

Eg: "**`cp -r COMP1511 COMP1511_backup`**" will copy all files from my **`COMP1511`** directory to my **`COMP1511_backup`** directory

Letting our Computer Make Decisions

- Sometimes we want to make decisions based on what information we have at the time
- We can let our program branch between sets of instructions
- In C this is the **if** statement



The if statement

An **if** is like a question and an answer

- First we ask a question
- If we get the right answer, we run some code

```
// the code inside the curly brackets
// runs if the expression is true (not zero)
if (expression) {
    code statement;
    code statement;
}
```

else - Adding to if statements

We can expand beyond the simple **if** by adding the **else** statement

```
if (expression) {
    // this runs if the expression results in
    // anything other than 0 (true)
} else {
    // this runs if the earlier expression
    // results in 0 (false)
}
```

Chaining ifs and elses

This code shows ifs and elses joined together

```
if (expression1) {
    // this runs if expression1 is true
    // (anything other than 0)
} else if (expression2) {
    // this runs if expression1 is false (results in 0)
    // and expression2 is true (results in anything
    // other than 0)
} else {
    // this runs if both expression1 and
    // expression2 result in false (0)
}
```

Asking the right Question

For our **if** to perform correctly, we need to know how to ask questions

Relational Operators work with pairs of numbers:

- `<` less than
- `>` greater than
- `<=` less than or equal to
- `>=` greater than or equal to
- `==` equals (we've already used "=" to assign values, so we use "==" to ask a question)
- `!=` not equal to

All of these will result in 0 if false and a 1 if true

Chaining Questions Together

We use **Logical Operators** to compare expressions

The first two are used between two expressions

- `&&` *AND* equates to 1 if both sides equate to 1
- `||` *OR* is 1 if either side is 1

This is used in front of an expression:

- `!` *NOT* is the opposite of whatever the expression was

Some examples

Expression	Result
`5 < 10`	1
`8 != 8`	0
`12 <= 12`	1
`7 < 15 && 8 >= 15`	0
`7 < 15 || 8 >= 15`	1
`!(5 < 10 || 6 > 13)`	0

Let's create a program with our new skills

This program will help us in our games of "Catacombs and Large Reptiles"

1. A user will roll two dice and tell us the result of each die
2. Our program will add them together and check them against a target number that only the program knows.
3. It will then report back whether the total of the dice was higher, equal or lower than the secret number.

What does our program need?

All recipes need ingredients

- A way to “talk” to our user
  - We know about **printf**
- A way to receive input
  - We learnt about **scanf** today
- A way to compare numbers . . .
  - **Relational Operators**
- . . . Against a secret number
  - A **variable** or a **constant**
- A way to run different code depending on the number comparisons
  - **If** and **else** conditional statements

Describe our program

We'll write some comments and include stdio.h for printf and scanf

```
/*  The Dice checker example
    Marc Chee, September 2020

    This small example will ask the user to input the
    result of rolling two dice.
    It will then check the sum of them against its
    secret number.
    It will report back:
        success (higher or equal)
        or failure (lower)
*/

#include <stdio.h>
```

Define our Secret Number

`#define` is nice for things that we know aren't going to change. Note the use of all caps to signify a constant and underscores to show different words

This will go after our **`#include`**, but before our main

```
#define SECRET_TARGET 7
```

Main function

We always need a main function for C to know where our program starts

```
int main(void) {
}
```

Setting up some variables

We know we’re going to be getting dice values from our user, so we can start by declaring them

```
// set up some dice variables so we can store numbers
int die_one;
int die_two;
```

Talk to our user and ask them for their dice rolls

Using printf and scanf, we can print words to the screen and read numbers

We store the two die rolls in the variables we set up earlier

```
// we start by asking the user for their dice rolls
printf("Please enter your first die roll: ");
// then read in a number they type in the terminal
scanf("%d", &die_one);
// repeat for the second die
printf("Please enter your second die roll: ");
scanf("%d", &die_two);
```

Total the dice

Using some basic arithmetic, we calculate our total

We then save that value in a “**`total`**” integer variable

```
// calculate the total and report it
int total = die_one + die_two;
printf("Your total roll is: %d\n", total);
```

Test the Total against the Target

We now use an if statement to test for success

```
// Now test against the secret number
if (total >= SECRET_TARGET) {
    // success
    printf("Skill roll succeeded!\n");
}
```

What about the failure?

The other option, which we actually don't have to test for, because it's all that's left.

```
// Now test against the secret number
if (total >= SECRET_TARGET) {
    // success
    printf("Skill roll succeeded!\n");
} else {
    // the same as total < SECRET TARGET
    // but we don't have to test it because
    // we've already checked all other
    // possibilities
    printf("Skill roll failed!\n");
}
```

We have a dice check program!

The finished code is now in http://web.cse.unsw.edu.au/~marcchee/lecture02/

Challenges:

Can you modify this code to:

- Detect exact ties as well as success and failure?
- What about the idea of a "critical double"? Can you detect when the player rolled the same number on both dice and report it as a "critical" success, tie or failure?
- What about randomisation? (This is much harder and might need some things from later in the term)

What did we learn today?

Variables

- They come in different sizes and types
- Printing from variables and reading user input into variables
- Using maths to manipulate variables

Conditions

- **if** and **else** statements
- Relational Operators and Logical Operators