COMP1511 PROGRAMMING FUNDAMENTALS

LECTURE 4

Loop the loop

LAST LECTURE...

ON MONDAY

- Basic IF statements
- Conditionals - running our code based on some sort of condition being met
- More complex IF statements
- Catching scanf errors with IF statements
- While loops
    - Conditional

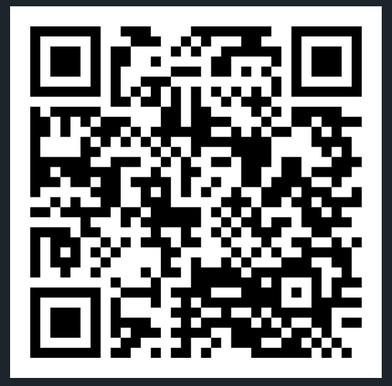
IN THIS LECTURE

TODAY...

- Refresh
- While loops
- A loop inside a loop
- Custom data types:
  - Structs
  - Enums

“

WHERE IS THE CODE?



Live lecture code can be found here:

HTTPS://CGI.CSE.UNSW.EDU.AU/~CS1511/23T1/LIVE/WEEK02/

REFRESHER

IFS AND LOOPS OH MY!

- Tea or coffee?
- Keep drinking tea until you ask for coffee

WHILE

REPETITIVE TASKS SHOULDN'T REQUIRE REPETITIVE CODING

- C normally executes in order, line by line (starting with the main function after any # commands have been executed)
  - if statements allow us to "turn on or off" parts of our code
  - But up until now, we don't have a way to repeat code
- Copy-pasting the same code again and again is not a feasible solution
- Let's see an example where it is inefficient to copy and paste code...

WHILE

WHILE SOMETHING IS TRUE, DO SOMETHING

- **`while()`** loops - can commonly be controlled in three ways:
  - Count loops
  - Sentinel loops
  - Conditional loops

```
1 while (expression) {
2     // This will run again and again until
3     // the expression is evaluated as false
4  }
5 // when the program reaches this }, it will
6 // jump back to the start of the while loop
```

WHILE

CONTROL THE WHILE LOOP

```
1 // 1. Initialise the loop control variable
2 // before the loop starts
3
4 while (expression) { // 2. Test the loop
5                       // control variable,
6                       // done within the
7                       // (expression)
8
9     // 3. Update the loop control variable
10    // usually done as the last statement
11    // in the while loop
12 }
```

TO INFINITY AND BEYOND

TERMINATING YOUR LOOP

- It's actually very easy to make a program that goes forever
- Consider the following while loop:

```c
// To infinity and beyond!

while (1 < 2) {
    printf("<3 COMP1511 <3");
}
```

CONTROL THE WHILE LOOP

COUNT LOOPS

- Use a variable to control how many times a loop runs - a ”loop counter”
- It’s an `int` that’s declared outside the loop
- It’s “termination condition” can be checked in the while expression
- It will be updated inside the loop

```
1 // 1. Declare and initialise a loop control
2 // variable just outside the loop
3 int count = 0;
4
5 while (count < 5) { // 2. Test the loop
6                     // control variable
7                     // against counter
8     printf("I <3 COMP1511");
9
10    //Update the loop control variable
11    count = count + 1;
12 }
```

CONTROL THE WHILE LOOP

COUNT LOOPS

```
int scoops = 0;
int sum = 0;

// 1. Declare and initialise a loop control
// variable just outside the loop
int serves = 0;

while (serves < 5) { // 2. Test the loop
                     // control variable
                     // against counter
    printf("How many scoops of ice cream have
    you had?");
    scan("%d", &scoops);
    sum = sum + scoops;
    printf("You have now had %d serves\n", serves);
    printf("A total of %d scoops\n", sum);
    serves = serves + 1; // 3. Update the loop
                         //  control variable
}
printf("That is probably enough ice-cream\n");
```

SENTINEL VALUES

WHAT IS A SENTINEL?

- When we use a loop counter, we assume that we know how many times we need to repeat something
- Consider a situation where you don't know the number of repetitions required, but you need to repeat whilst there is valid data
- A sentinel value is a 'flag value', it tells the loop when it can stop...
- For example, keep scanning in numbers until an odd number is encountered
    - We do not know how many numbers we will have to scan before this happens
    - We know that we can stop when we see an odd number

CONTROL THE WHILE LOOP

SENTINEL LOOPS

- Sentinel Loops: can also use a variable to decide to exit a loop at any time
- We call this variable a ”sentinel”
- It’s like an on/off switch for the loop
- It is declared and set outside the loop
- It’s “termination condition” can be checked in the while expression
- It will be updated inside the loop (often attached to a decision statement)

CONTROL THE WHILE LOOP

SENTINEL LOOPS

```c
int scoops = 0;
int sum = 0;

// 1. Declare and initialise a loop control
// variable just outside the loop
int end_loop = 0;

while (end_loop == 0) { // 2. Test the loop
                        // control variable
    printf("Please enter number of scoops today: ");
    scan("%d", &scoops);
    if (scoops > 0) {
        sum = sum + scoops;
    } else {
        end_loop = 1; // 3. Update the loop
                      // control variable
    }
}
```

CONTROL THE WHILE LOOP

CONDITIONAL LOOPS

- Conditional Loops: can also use a condition to decide to exit a loop at any time
- This is called conditional looping
- Also do not know how many times we may need to repeat.
- We will terminate as a result of some type of calculation

CONTROL THE WHILE LOOP

COUNT LOOPS

```
int scoops = 0;

// 1. Declare and initialise a loop control variable
// Since I want the sum to be as close to 100
// as possible, that is my control condition
int sum = 0;

while (sum < 100) { // 2. Test the loop
                    // condition
    printf("Please enter number of scoops: ");
    scan("%d", &scoops);

    // 3. Update the loop control variable
    sum = sum + scoops;
}
printf("Yay! You have eaten %d scoops of ice cream", sum);
```

ACTION TIME

CODE DEMO

- While loop with a counter:
`while_count.c`
- While loop with a sentinel:
`while_sentinel.c`
- While loop with a condition:
`while_condition.c`

WHILE INSIDE A WHILE

PUTTING A LOOP INSIDE A LOOP

- If we put a loop inside a loop . . .
- Each time a loop runs
- It runs the other loop
- The inside loop ends up running a LOT of times

PROBLEM TIME

PRINT OUT A GRID OF NUMBERS

- Print out a grid of numbers:

1 2 3 4 5
1 2 3 4 5
1 2 3 4 5
1 2 3 4 5
1 2 3 4 5

- Break down the problem...
- Get it down to a component that you can do...

PROBLEM TIME

PRINT OUT A PYRAMID OF NUMBERS

- What if we now print out a half pyramid of numbers:

1
1 2
1 2 3
1 2 3 4
1 2 3 4 5

- Break down the problem...
- Get it down to a component that you can do...

ACTION TIME

CODE DEMO

- While loop print a grid:
  `grid.c`
- While loop print a pyramid:
  `pyramid.c`

BREAK TIME

TIME TO STRETCH

There are 50 motor bikes, each has a petrol tank holding enough petrol to go 100km. Using these motor bikes, what is the maximum distance you can go?

ORGANISING DIFFERENT TYPES INTO ONE RELATED WHOLE

USER DEFINED DATA TYPE `struct`

- Structures…. Or **`struct`** (as they are known in C!)
- Structs (short for structures) are a way to create custom variables
- Structs are variables that are made up of other variables

STRUCTURES

WHAT? WHY? EXAMPLES?

- What happens if you wanted to group some variables together to make a single structure?
- Why do we need structures?
  - Helps us to organise related but different components into one structure
  - Useful in defining real life problems
- What are some examples in real life where some things go together to make a single component?

HOW DO WE CREATE A STRUCT?

To create a struct, there are three steps:

1. Define the struct (outside the main)
2. Declare the struct (inside your main)
3. Initialise the struct (inside your main)

1. DEFINING A STRUCT

WHAT AM I GROUPING TOGETHER INTO ONE WHOLE? LET'S USE AN EXAMPLE OF A COORDINATE POINT

Because structures are a variable that we have created, made up of components that we decided belong together, we need to define what the struct (or structure is). To define a struct, we define it before our main function and use some special syntax.

```
1 struct struct_name {
2       data_type variable_name_member;
3       data_type variable_name_member;
4       ...
5   };
```

1. DEFINING A STRUCT

WHAT AM I GROUPING TOGETHER INTO ONE WHOLE? LET'S USE AN EXAMPLE OF A COORDINATE POINT

For example, using the coordinate point example, to make a structure called coordinate, that has two members - the x_coordinate and the y_coordinate:

```
1 struct coordinate {
2       int x_coordinate;
3       int y_coordinate;
4   };
```

2. DECLARING A STRUCT

INSIDE YOUR MAIN

To declare a struct, inside the main function (or wherever you are using the structure - more on this later)...

```
1 struct struct_name variable_name;
```

For example, using the coordinate point example, to declare a variable, cood_point, of type struct coordinate

```
1   struct coordinate cood_point;
```

3.INITIALISE A STRUCT

INSIDE YOUR MAIN

```
struct coordinate {
      int x_coordinate;
      int y_coordinate;
  };
```

We access a member by using the dot operator .

```
  variable_name.variable_name_member;
```

For example, using the coordinate point example, with variable name: cood_point, trying to access the x coordinate:

```
cood_point.x_coordinate;
```

LET'S SEE IT ALL TOGETHER FOR A COORDINATE POINT

1. DEFINE
2. DECLARE
3. INITIALISE

1. DEFINE

Inside the main function

```c
// Define a structure for a coordinate point

struct coordinate {
     int x_coordinate;
     int y_coordinate;
 };
```

2. DECLARE

Inside the main function

```c
// Declare structure with variable name

struct coordinate cood_point;
```

3. INITIALISE

Inside the main function

```c
// Access stuct member to assign value

cood_point.x_coordinate = 3;
cood_point.y_coordinate = 5;
```

ENUMERATIONS

USER DEFINED DATA TYPE `enum`

- Integer data types that you create with a limited range of values (enumerated constants)
- Used to assign names to integral constants
  - the names make the program easier to read and maintain

```c
// Enumerations in C using the keyword enum

// For example, to define an enum you use
// the following syntax:
enum enum_name {state0, state1, state2, ...}

// Defining an enum with days of the week as an
// example:
enum weekdays {Mon, Tue, Wed, Thu, Fri, Sat, Sun}

// Using a flag as an example and we can also
// assign values (force something other than start
// at 0):
enum state_flag {Success = 1, Fail = 2}
```

ENUMERATIONS

USER DEFINED DATA TYPE `enum`

```c
// Enumerations in C using the keyword enum
// Using in a simple program

#include <stdio.h>

// Defining an enum:
enum weekdays {Mon, Tue, Wed, Thu, Fri, Sat, Sun}

int main (void) {
    // Declaring the use of enum weekdays called
    // day
    enum weekdays day;
    day = Sat;
    printf("The day number is %d\n", day);
    // This will print out 5, as the count starts
    // at Mon (0).... Sat (5)
    return 0;
}
```

ENUMERATIONS

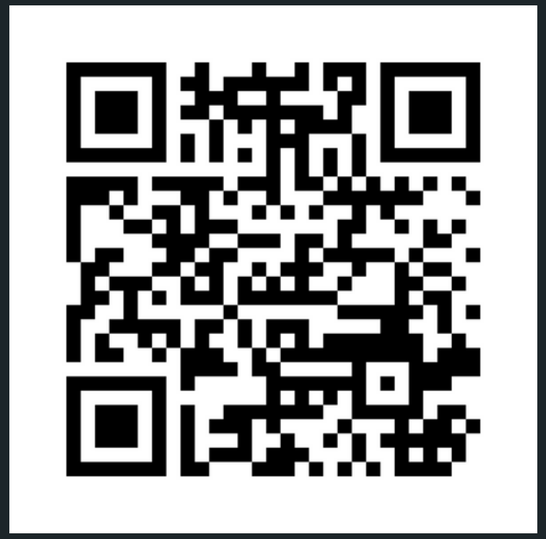
FOR EXAMPLE USING MENU ITEMS, IMAGINE IF AN ICE CREAM SHOP HAD 57 FLAVOURS!

```c
// Enumerations in C using the keyword enum

// Defining an enum with ice-cream names:
enum icecream {Dulce, Vanilla, Choc, Pistachio, Strawberry, Mint}

#include <stdio.h>

int main(void) {
  // Declare menu choice
  enum icecream menu_choice;
  menu_choice = Dulce;
  printf("Kitchen order for %d item received", menu_choice);

  return 0;
}
```

WHY ENUMS?

`enum vs #define`

- The advantages of using enums over #defines:
  - Enumerations follow scope rules:
    - You cannot have an enum state that is the same in two different types of enums
  - Enumerations are automatically assigned values, which makes the code easier to read
    - Think of the case where you have a large number of constants (error codes for example!?)
  - We use enums when we want a variable to have a specific set of values



Feedback please!

I value your feedback and use to pace the lectures and improve your overall learning experience. If you have any feedback from today's lecture, please follow the link below. Please remember to keep your feedback constructive, so I can action it and improve the learning experience.

https://www.menti.com/algg42qd777z

WHAT DID WE LEARN TODAY?

LOOP THE LOOP WHILE (COUNTER)

while_counter.c

LOOP THE LOOP WHILE (SENTINEL)

while_sentinel.c

LOOP THE LOOP WHILE (CONDITION)

while_condition.c

LOOP INSIDE A LOOP (CAN'T GET ENOUGH OF A LOOP)

grid: grid.c

pyramid: pyramid.c

WHAT DID WE LEARN TODAY?

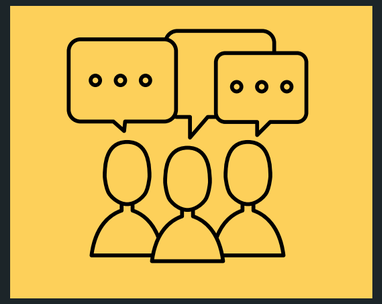
STRUCTURES

struct.c

ENUMERATIONS

enum.c

REACH OUT



CONTENT RELATED QUESTIONS

Check out the forum

ADMIN QUESTIONS

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