Lecture 8

Repetition: Loops!

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The slides are mainly from Sharanya Jayaraman

Repetition Statements

- Repetition statements are called loops, and are used to repeat the same code mulitple times in succession.
- The number of repetitions is based on criteria defined in theloop structure, usually a true/false expression
- The three loop structures in C++ are:
  - `while`
  - `do-while`
  - `for`
- Three types of loops are not actually needed, but having the different forms is convenient

while and do-while loops

- Format of while loop:

```
        while (expression)
           statement
```

- Format of do/while loop:

```
  do
     statement
  while (expression);
```

- The expression in these formats is handled the same as in the if/else statements discussed previously (0 means false, anything else means true)
- The "statement" portion is also as in if/else. It can be a single statement or a compound statement (a block {}).

while and do-while loops

- We could also write the formats as follows (illustrating more visually what they look like when a compound statement makes up the loop "body"):

```
while (boolean expression)
{
   statement1;
   statement2;
   // ...
   statementN;
}
```

while and do-while loops

- The same can be done for the do-while loop:

```
do
{
   statement1;
   statement2;
   // ...
   statementN;
} while (boolean expression)
```

How they work

- The expression is a test condition that is evaluated to decide whether the loop should repeat or not.
  - true means run the loop body again.
  - false means quit.
- The while and do/while loops both follow the same basic flowchart – the only exception is that:
  - In a `while` loop, the expression is tested first
  - In a `do/while` loop, the loop “body” is executed first

Examples

- Both of these examples add all the numbers from 1 through 50.

```
// while loop example
int i = 1,
int sum = 0;
while (i <= 50) // Q: # loops? # eval
    expression?
{
   sum += i; // means: sum = sum + i
   i++;          // means: i = i + 1
}
cout <<"Sum of numbers from 1 through 50 is"
    <<sum <<endl;
```

Examples

- Both of these examples add all the numbers from 1 through 50.

```
// while loop example
int i = 1,
int sum = 0;
while (i <= 50) //loop runs 50 times,
    condition checked 51 times
{
   sum += i; // means: sum = sum + i
   i++;          // means: i = i + 1
}
cout <<"Sum of numbers from 1 through 50 is"
    <<sum <<endl;
```

Examples

- Both of these examples add all the numbers from 1 through 50.

```
// while loop example
int i = 1, sum = 0;
do
{
   sum += i; // means: sum = sum + i
   i++;          // means: i = i + 1
} while (i <= 50) // Q: # loops? # eval
    expression?
cout <<"Sum of numbers from 1 through 50 is"
    <<sum <<endl;
```

Examples

- Both of these examples add all the numbers from 1 through 50.

```
// while loop example
int i = 1, sum = 0;
do
{
   sum += i; // means: sum = sum + i
   i++;          // means: i = i + 1
} while (i <= 50) //loop runs 50 times,
    condition checked 50 times
cout <<"Sum of numbers from 1 through 50 is"
    <<sum <<endl;
```

The `for` loop

- The `for` loop is most convenient with counting loops – i.e., loops that are based on a **counting variable, usually a known number of iterations**
- Syntax of `for` loop

```
        for (initialCondition; boolean Expression;
            iterativeStatement)
```

The for loop

- Remember that the statement can be a single statement or a block, so an alternate format might be:

```
for (initialCondition; boolean Expression;
     iterativeStatement)
{
    statement1;
    statement2;
    // ...
    statementN;
}
```

How it works

- The initialCondition runs once, at the start of the loop
- The testExpression is checked at very iter. (This is just like the expression in a while loop). If it's false, quit. If it's true, then:
    - Run the loop body
    - Run the iterativeStatement
    - Go back to the testExpression step and repeat

How it works

- Example

```
// Q: # of loops? # condition checked? #
    increment?
int i, sum = 0;
for (i = 1; i <= 50; i++)
{
   sum += i;
}
cout <<"Sum of numbers from 1 through 50 is "
    << sum << endl;
```

How it works

- Example

```
// loop runs 50 times, condition checked 51
    times
int i, sum = 0;
for (i = 1; i <= 50; i++)
{
   sum += i;
}
cout <<"Sum of numbers from 1 through 50 is "
    << sum << endl;
```

Question

How many times “Hello World” are printed?

```
for (int i = 0; i <10; i++)
   cout << "Hello" << endl ;
```

```
for (int i = 1; i <10; i++)
   cout << "Hello" << endl ;
```

```
for (int i = 0; i <10; ++i)
   cout << "Hello" << endl ;
```

Question

How many times “Hello World” are printed?

```
    for (int i = 0; i <10; i++)
        cout << "Hello" << endl ; // 10 times
```

```
    for (int i = 1; i <10; i++)
        cout << "Hello" << endl ; // 9 times
```

```
    for (int i = 0; i <10; ++i)
        cout << "Hello" << endl ; // 10 times
```

More for loop

- For loops also do not have to count one-by-one, or even upward. Examples:

```
        for (i = 100; i >0; i--)
        for (c = 3; c <= 30; c+=4)
```

The first example gives a loop header that starts counting at 100 and decrements its control variable, counting down to 1 (and quitting when i reaches 0).

The second example shows a loop that begins counting at 3 and counts by 4's (the second value of c will be 7, etc).

More for loop

- There could be multiple statements of initialCondition, testExpression, iterativeStatement

```
int a=0;
for (int i=0, j=10; i<5; ++i, j-=2, a+=j) {
   // loop body
}
// a = ?
```

More for loop

- Loops can also be nested. This prints a rectangle

```
for (int i = 0; i <10; i++){
   for (int j = 0; j <15; j++)
   {
         cout <<"*";
   }
   cout <<endl;
}
```

Some notes on the `for` loop

- It should be noted that if the control variable is declared inside the for header, it only has scope through the for loop's execution.

  Once the loop is finished, the variable is out of scope:

```
for (int counter = 0; counter <10; counter++){
   // loop body
}
cout << counter; // illegal. counter out of
    scope
```

Some notes on the `for` loop

- This can be avoided by declaring the control variable before the loop itself.

```
int counter; // declaration of control
    variable
for (counter = 0; counter <10; counter++)
{
   // loop body
}
cout <<counter; // OK. counter is in scope
```

break and continue

- These statements can be used to alter the flow of control in oops, although they are not specifically needed. (Any loop can be made to exit by writing an appropriate test expression).
- break: This causes immediate exit from any loop (as well asfrom switch blocks).
- continues: When used in a loop, this statement causes the current loop iteration to end, but the loop then moves on to the next step.
  - In a while or do-while loop, the rest of the loop body is skipped, and execution moves on to the test condition.
  - In a for loop, the rest of the loop body is skipped, and execution moves on to the iterative statement.

Examples

```
int i = 0;
while true
{
   if (i < 100)
      cout << i;
   else
      break;
   i++;
}
```

```
for (int i = 0; i<100; i++) {
   cout << i;
}
```

Examples

```
for (int i = 0; i<100; i++) {
   if (i%2 == 0)
      cout << i
   else
      coninue
}
```

Examples

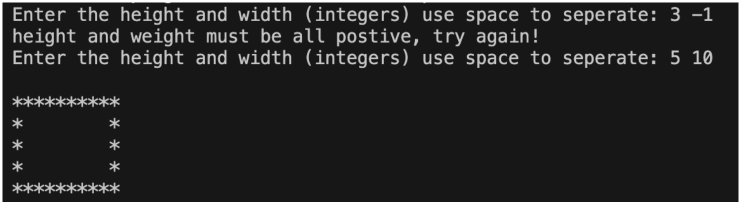
```
for (int i = 0; i<100; i++) {
   if (i%2 == 0)
   cout << i
   else
   coninue
}
```

```
for (int i = 0; i<100; i+=2) {
   cout << i;
}
```

Programming Exerceise

Task: Print the edges of a rectangle with ∗

- Ask the height and width from the user
- Should check user's inputs, make sure they are positive (safely addume integer) numbers
- Example



```
Enter the height and width (integers) use space to seperate: 3 -1
height and weight must be all postive, try again!
Enter the height and width (integers) use space to seperate: 5 10

**********
*        *
*        *
*        *
**********
```