Week 6: Intro to Loops

Gaddis: 5.2-6

CS 1428
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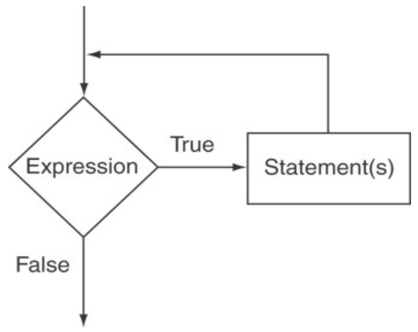
Control Flow (order of execution)

- So far, control flow in our programs has included:
  - sequential processing (1st statement, then 2nd statement…)
  - branching (conditionally skip some statements).
- Chapter 5 introduces loops, which allow us to conditionally repeat execution of some statements.
  - while loop
  - do-while loop
  - for loop

5.2 The `while` loop

- As long as the relational expression is true, repeat the statement



`while` syntax and semantics

- The while statement is used to repeat statements:

```
while (expression)
   statement
```

- How it works:
  - `expression` is evaluated:
  - If it is true, then `statement` is executed, then it starts over (and `expression` is evaluated again).
  - If it is false, then `statement` is skipped (and the loop is done).

`while` example

- Example:

```
int number = 1;

while (number <= 3)
{
   cout << “Student” << number << endl;
   number = number + 1;
}

cout << “Done” << endl;
```

Hand trace!

- Output

```
Student1
Student2
Student3
Done
```

5.3 Using `while` for input validation

- Inspect user input values to make sure they are valid.
- If not valid, ask user to re-enter value:

```
int number;

cout << “Enter a number between 1 and 10: “;
cin >> number;

while (number < 1 || number > 10) {
   cout << “Please enter a number between 1 and 10: “;
   cin >> number;
}

// Do something with number here
```

This expression is true when number is OUT of range.

Explain the valid values in the prompt

Don’t forget to input the next value

Input Validation

- Checking for valid characters:

```
char answer;

cout << “Enter the answer to question 1 (a,b,c or d): “;
cin >> answer;

while (answer != ‘a’ && answer != ‘b’ &&
       answer != ‘c’ && answer != ‘d’)
{
   cout << “Please enter a letter a, b, c or d: “;
   cin >> answer;
}

// Do something with answer here
```

5.4 Counters

- <u>Counter</u>: a variable that is incremented (or decremented) each time a loop repeats.
- Used to keep track of the number of iterations (how many times the loop has repeated).
- Must be initialized before entering loop!!!!

Counters

- Example (how many times does the user enter an invalid number?):

```
int number;
int count = 0;

cout << "Enter a number between 1 and 10: ";
cin >> number;

while (number < 1 || number > 10) {
   count = count + 1;
   cout << "Please enter a number between 1 and 10: ";
   cin >> number;
}

cout << count << " invalid numbers were entered." << endl;

// Do something with number here
```

Counters

- Example, using the counter to control how many times the loop iterates:

```
cout << "Number  Number Squared" << endl;
cout << "------  --------------" << endl;

int  num = 1;       // counter variable
while (num <= 8) {
   cout << num << "              " << (num * num) << endl;
   num = num + 1;   // increment the counter
}
```

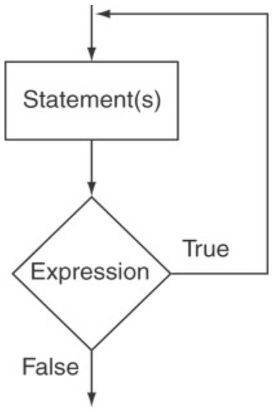
- Output:

```
Number  Number Squared
------  --------------
1            1
2            4
3            9
4            16
5            25
6            36
7            49
8            64
```

Q1,2,3,4,5

5.5 The `do-while` loop

- Execute the statement(s), then repeat as long as the relational expression is true.



`do-while` syntax and semantics

- The `do-while` loop has the test expression at the end:

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

Don't forget the semicolon at the end

- How it works:
  - `statement` is executed.
  - `expression` is evaluated:
  - If it is true, then it starts over (and `statement` is executed again).
  - If (when) it is false, the loop is done.
- `statement` always executes at least once.

do-while example

- Example:

```
int number = 1;
do
{
   cout << "Student" << number << endl;
   number = number + 1;
} while (number <= 3);

cout << "Done" << endl;
```

- Output

```
Student1
Student2
Student3
Done
```

do-while with menu

```
char choice;

do {
   cout << "A: Make a reservation." << endl;
   cout << "B: View flight status." << endl;
   cout << "C: Check-in for a flight." << endl;
   cout << "D: Quit the program." << endl;
   cout << "Enter your choice: ";

   cin >> choice;

   switch (choice) {
      case 'A':  // code to make a reservation
                 break;
      case 'B':  // code to view flight status
                 break;
      case 'C':  // code to process check-in
                 break;
   }
} while(choice != 'D');
```

Different ways to control the loop

- Conditional loop: body executes as long as a certain condition is true
  - input validation: loops as long as input is invalid
- Count-controlled loop: body executes a specific number of times using a counter
  - actual count may be a literal, or stored in a variable.
- Count-controlled loop follows a pattern:
  - initialize counter to zero (or other start value).
  - test counter to make sure it is less than count.
  - update counter during each iteration.

5.6 The for loop

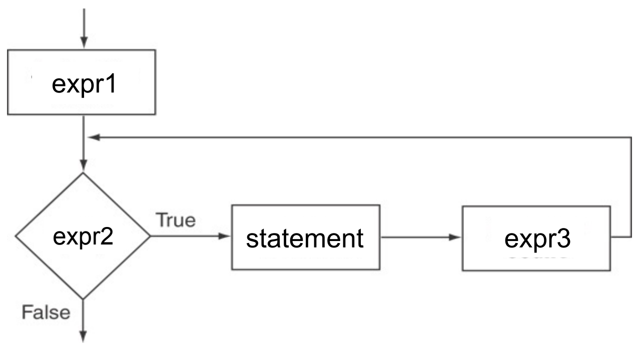
- The for statement is used to easily implement a count-controlled loop.

```
for (expr1; expr2; expr3)
   statement
```

- How it works:
  1. `expr1` is executed (initialization)
  2. `expr2` is evaluated (test)
  3. If it is true, then `statement` is executed,
     then `expr3` is executed (update),
     then go to step 2.
  4. If (when) it is false, then `statement` is skipped
     (and the loop is done).

The `for` loop flow chart

```
for (expr1; expr2; expr3)
   statement
```



The `for` loop and the `while` loop

- The for statement

```
for (expr1; expr2; expr3)
   statement
```

- is equivalent to the following code using a while statement:

```
expr1;            // initialize
while (expr2) {   // test
   statement
   expr3;         // update
}
```

`for` loop example

- Example:

Equivalent to `number = number + 1`

```
int number;
for (number = 1; number <= 3; number++)
{
   cout << "Student" << number << endl;
}

cout << "Done" << endl;
```

Note: no semicolon

- Output

```
Student1
Student2
Student3
Done
```

Counters: redo

- Example, using the counter to control how many times the loop iterates:

```
cout << "Number  Number Squared" << endl;
cout << "------  --------------" << endl;

int  num = 1;       // counter variable
while (num <= 8) {
   cout << num << "              " << (num * num) << endl;
   num = num + 1;   // increment the counter
}
```

- Rewritten using a for loop:

```
cout << "Number  Number Squared" << endl;
cout << "------  --------------" << endl;

int  num;
for (num = 1; num <= 8; num++)
   cout << num << "              " << (num * num) << endl;
```

Define variable in init-expr

- You may define the loop counter variable inside the for loop’s initialization expression:

```
for (int x = 10; x > 0; x=x-2)
   cout << x << endl;

cout << x << endl; //ERROR, can’t use x here
```

Hand trace!

- Do NOT try to access x outside the loop (the scope of x is the for loop statement ONLY)
- What is the output of the for loop?

User-controlled count

- You may use a value input by the user to control the number of iterations:

```
int maxCount;
cout << “How many squares do you want?” << endl;
cin >> maxCount;

cout << “Number  Number Squared” << endl;
cout << “------  --------------” << endl;

for (int num = 1; num <= maxCount; num++)
   cout << num << “           “ << (num * num) << endl;
```

- How many times does the loop iterate?

The exprs in the for are optional

- You may omit any of the three exprs in the for loop header

```
int value, incr;
cout << “Enter the starting value: “;
cin >> value;

for ( ; value <= 100; )
{
   cout << “Please enter the next increment amount: “;
   cin >> incr;
   value = value + incr;
   cout << value << endl;
}
```

- Style: use a while loop for something like this.
- When expr2 is missing, it is true by default.