CSC 211: Object Oriented Programming

Loops (while, do while) and nested loops

Michael Conti

Department of Computer Science and Statistics
University of Rhode Island

Spring 2020

THINK BIG  WE DO℠

Original design and development by Dr. Marco Alvarez

Administrative Notes

Homework Assignment 01 (Due Date 2/24)

This assignment is about operators, expressions, data types, and selection statements. **Arrays, functions, and loops are not allowed. The only libraries allowed for this assignment are** `<iostream>` **and** `<iomanip>`. This assignment is to be completed individually. You are not allowed to share your code with other students. The assignment is worth a total of 100 points. If you have any questions or need any help, please visit us during office hours and/or post questions on Piazza.

> If you need to post any of your actual source code on Piazza for any reason, **please** be sure to tag the post as being *visible to instructors only*, so that you don't inadvertently share code with others and violate class rules.

Format details

Your submission will be tested and graded by an autograder, for this reason it cannot be stressed enough that your program must exactly follow the specifications for input and output upon submission.

If the question specifies that it will take a `double` then a `char` you must follow this input order or else fail the test. For this assignment, you should use the `int` data type for regular whole numbers and as the default when a number format is not specified, you should use the `double` data type for any question which specifies decimal or floating point numbers, and `char` for single letter variables or input.

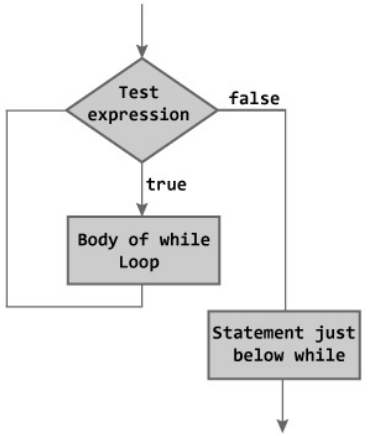
The output will always be some form of string printed out on a single line. It will always begin on a new line and end with some form of newline character; either `std::endl` or `'\n'`. Whenever printing a `double` you should always have exactly 4 decimal places; if your decimal number is `3.1415926534`, you should print it as `3.1416`. If your number is `0.0` or `0`, it should print as `0.0000`. You can use `<iomanip>` to accomplish this.

For details on expected submission instructions, please refer to the **Submission and Grading** section at the bottom of the document.

1. *Addition*. This program should prompt the user for two numbers, then output the following string: `<a> + <b> = <c>` where `a` is the first number given, `b` is the second, and `c` is the sum. (eg. `5 + 7 = 12`).
2. *Subtraction*. Prompt the user for two numbers, then output the following string: `<a> - <b> = <c>` similar to problem 1 except using subtraction instead of addition.
3. *Division*. Prompt the user for two *integer* numbers, then output the following string: `<a> / <b> = <c>`. Integer division can lose precision as we discussed in lab, but we won't worry about that here.

the `while` loop

Flowchart of `while` statement




```
// ...
// statements above
// ...

while (test_expression) {
    // body of while
}

// ...
// statements below
// ...
```

Figure: Flowchart of while Loop

https://www.programiz.com/cpp-programming/do-while-loop

A *while* Statement with a Single Statement Body

```
while (Boolean_Expression)
    Statement
```

Body

A *while* Statement with a Multistatement Body

```
while (Boolean_Expression)
{
  Statement_1
  Statement_2
      .
      .
      .
  Statement_Last
}
```

Body

from: Problem Solving with C++, 10th Edition, Walter Savitch

What is the output?

```
int n = 2019;

while (n > 0) {
    std::cout << n % 10 << std::endl;
    n /= 10;
}
```


Question

- Write a single while loop to print the powers of two from 2^0 to 2^{16}

What is the output?

```
int main() {
    int n, i = 0;

    std::cin >> n;
    while (i < n)
        std::cout << i << ',';
        i ++;
}
```

"The truth of the story lies in the details"

Any `for` loop can be rewritten as a `while` loop, and vice-versa

`do-while`, `break`, `continue`

Flowchart of `do-while` statement

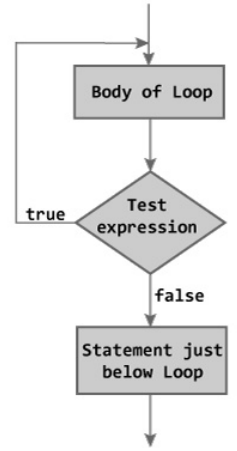


Figure: Flowchart of do...while Loop

```
// ...
// statements above
// ...

do {
    // body of do-while
} while (test_expression);

// ...
// statements below
// ...
```

https://www.programiz.com/cpp-programming/do-while-loop

Example

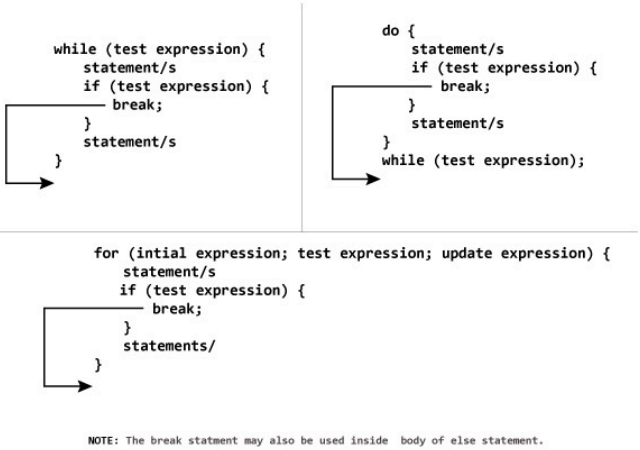
```
int num;

do {
    std::cout << "Enter a number: ";
    std::cin >> num;
} while (num < 0 || num > 100);

// do something with num
// ...
```

`break` statement

- The `break` statement will cause an **immediate exit**

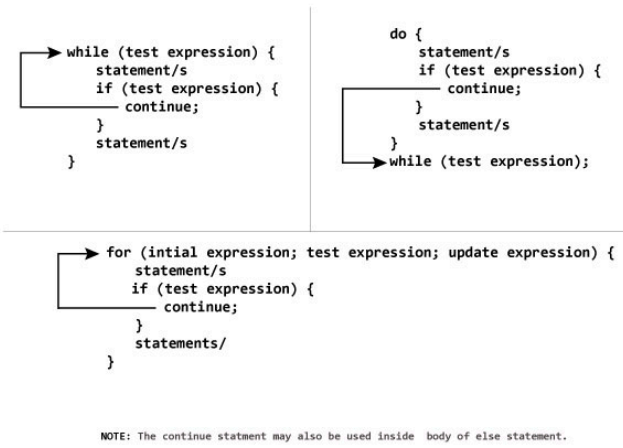


NOTE: The break statment may also be used inside body of else statement.

https://www.programiz.com/cpp-programming/break-continue

`continue` statement

- The `continue` statement will **interrupt an iteration**



NOTE: The continue statment may also be used inside body of else statement.

https://www.programiz.com/cpp-programming/break-continue

What is the output?

```
for (int i = 1 ; i <= 10 ; i++) {
    if (i % 2 == 0) {
        continue;
    } else {
        std::cout << i << " ";
    }
}
```


A single repetition of the loop body is called **Iteration**

Loops everywhere …

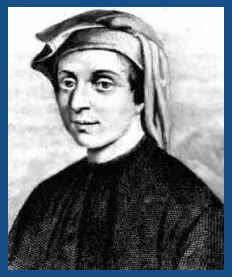
https://techterms.com/definition/rendering

Fibonacci sequence

$$F_0 = 0$$

$$F_1 = 1$$

$$F_n = F_{n-1} + F_{n-2}$$



0 1 1 2 3 5 8 13 21 34 …

The **Fibonacci sequence** first appears in the book **Liber Abaci** (1202) by Fibonacci, using it to calculate the growth of rabbit populations. The sequence had been described by Indian mathematicians as early as the **sixth century**.

from: wikipedia

Question?

- Write a program to print the first 50 terms of the Fibonacci sequence (pick your favorite loop)

Nested loops

Question

- Output the following pattern using a single loop

```
++++++++++
++++++++++
++++++++++
++++++++++
++++++++++
```


Another solution …

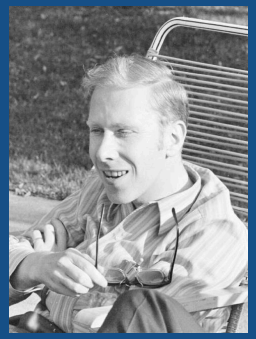
- **Nested loops**: loops inside loops

outer loop

```
for (int i = 0 ; i < 5 ; i ++) {
    for (int j = 0 ; j < 10 ; j ++) {
        std::cout << '+';
    }
    std::cout << std::endl;
}
```

inner loop

"Simple, elegant solutions are more effective, but they are harder to find than complex ones, and they require more time, which we too often believe to be unaffordable"



Niklaus Wirth, a Swiss computer scientist. In 1984 he won the Turing Award for developing a sequence of innovative computer languages: Euler, Pascal, Modula, etc.

from: wikipedia

What is the output?

```
for (int i = 0 ; i < 5 ; i++) {
    for (int j = 0 ; j < (i + 1) ; j++) {
        std::out << '+';
    }
    std::cout << std::endl;
}
```

Question

- Output the following pattern using nested loops

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


Question?

- Write a program to draw a box given **width** and **height**

width: 12
height: 4

Question?

- Write a program that outputs all prime numbers from 1 to 100