07 - Loops and Formatting

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Outline

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Loop Overview

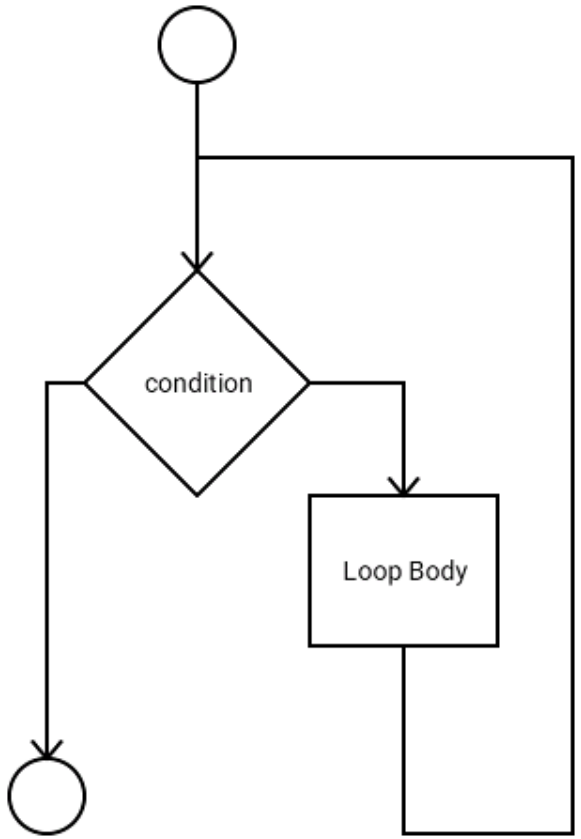
- Loops allow segments of code to be repeated.
- Loop operation is similar to branches; they are based on true/false conditions.
- C++ provides 3 types of loops: `while`, `do..while`, and `for`.

The While Loop

While Loop Syntax

```
while( condition )
    statement/block
```

- If the *condition* is true, the loop body is executed.
- After the loop body executes, the process begins again.
- How many times will the loop body execute?
  - Zero or more times!



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Example: `count.cpp`

- `count.cpp` is in your `examples/07-Loops` directory.
- Examine this file (use `less`)
- Compile and run the count program.
- The loop part of the file is shown below:

```
//start at zero
num = 0;

//count to 10
while(num <= 10) {
    //display the number
    cout << num << endl;

    //go to the next number
    num = num + 1;
}
```

Increment and Decrement Operators

- Adding (or subtracting) 1 to a variable is quite common in loops.
- To facilitate this, C++ has an increment operator (`++`) and a decrement operator(`--`).
- Both operators have a prefix version:

  `++x`

  `--x`
- Both operators have a postfix version:

  `x++`

  `x--`

Prefix Increment and Decrement

Prefix Increment and Decrement

The prefix operators increment the variable and returns the **new** value.

Sample Evaluation

Statement	Screen Output	Value of X
`x=0;`		Undefined
`0;`		0
`cout « ++x;`		0
`cout « 1;`		1
`cout;`	`1`	1

Postfix Increment and Decrement

Postfix Increment and Decrement

The postfix operators increment the variable and returns the **old** value.

Sample Evaluation

Statement	Screen Output	Value of X
`x=0;`		Undefined
`0;`		0
`cout « x++;`		0
`cout « 0;`		1
`cout;`	0	1

Operator Precedence (thus far)

Operator	Description	Associativity
`a++, a--`	Postfix increment and decrement	Left-to-Right
`not, !` `++a, --a`	Logical Not Prefix increment and decrement	Right-to-Left
`a*b, a/b, a%b`	Multiply, Divide, Modulus	Left-to-Right
`a+b, a-b`	Addition and Subtraction	Left-to-Right
« , »	Insertion and Extraction	Left-to-Right
`<, <=` `>, >=`	Relational Operators	Left-to-Right
`==, !=`	Equality Operators	Left-to-Right
`and, &&`	Logical And	Left-to-Right
`or, ||`	Logical Or	Left-to-Right

`=,`
`+=, -=`
`*=, /=`
`%=`
	Assignment and Assignment	Right-to-Left

Lab Activity: Using Increment Operator With `count.cpp`

1. Copy `count.cpp` to your `labs/week4` directory.
2. Open your copy in your favorite text editor, and locate the following line:
   ```
   num = num + 1;
   ```
3. Change this line to:
   ```
   num++;
   ```
4. Test your program to make sure it still works.
5. **Discuss**: Does it matter if we use the prefix or postfix operator in this case?

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Lab Activity: `count2.cpp`

We are going to create a new program that counts from `start` to `end` by some `increment`.
For example, count from 0 to 100 by fives

1. Copy `count.cpp` to `count2.cpp`
2. Open `count2.cpp` in the text editor of your choice.
3. Add variables for `start`, `end`, and `increment`.

```
int start; //The first number
int end;   //The last number
int increment;  //The amount to add each tim
```

4. Modify the program so that the first thing it does is prompt the user and read in these three variables.

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Lab Activity: `count2.cpp` Continued

- Modify the program so that instead of starting at zero, it starts at `start`.

```
//start at start
num = start;
```

- Modify the program so that instead of adding 1 to `num` each time through the loop, it adds `increment`.

```
//go to the next number
num += increment;
```

- Compile and test your program.

Loop Problem: Fahrenheit Scale

- In 1724, Daniel Fahrenheit proposed a precise way to measure temperature.
- His scale was reproducible and brilliant!
- 0 was fixed at the temperature achieved by mixing equal quantities of water, ice, and ammonia chloride.
- 100 is the temperature of healthy blood.
- The scale is divided into equal marks from 0 to 100.

Daniel Fahrenheit

Image Source: `https://en.wikipedia.org/wiki/Daniel_Gabriel_Fahrenheit`

Loop Problem: Celsius Scale

- In 1742, Anders Celsius proposed a new scale.
- Celsius's scale was, I think you'll agree, completely unrelatable.
- For 0, Celsius used the freezing point of water at sea level.
- For 100, Celsius used the boiling point of water at sea level.
- Only the United States holds fast to the bitter salt slush to blood scale.
- God bless the USA, and long live the imperial system of units!

Anders Celsius

Image Source:

`https://en.wikipedia.org/wiki/Anders_Celsius`

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Loop Problem: Fahrenheit to Celsius Table

- In reluctant deference to the people who use the inferior scale (96% of the world's population), we will produce a table converting from Fahrenheit to Celsius.
- The table will allow the user to specify the starting temperature, ending temperature, and increment.
- The table should be nicely formatted.
- The formula for doing the conversion is:

$$c = \frac{5}{9}(f - 32)$$

- Let's talk about the design of this program for a minute.

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Loop Problem: Fahrenheit to Celsius Table (continued)

1. Copy `count2.cpp` to `fahrenheit.cpp`
2. Change all mentions of the variable `num` to `f`
3. Change all variable types to `double`
4. Add a variable `c`
5. Alter the program so that the first thing it does is display a welcome message.

   ```
   Fahrenheit to Celsius Temperature Table
   ```
6. Just before the `while` loop,have the program print a header on a line by itself:

   ```
   Fahrenheit  Celsius
   ```
7. At the beginning of the loop body, add code to compute the Celsius value `c` from the fahrenheit value `f`.
8. Alter the line that prints out `f` so that it prints the fahrenheit and Celsius temperatures.
9. Compile and test your program.

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`cout` and Fields

- `cout` does its work by translating its input into a string of characters.
- Every « operations that results in output is called a **field**.
- There exist a series of flags which affect how `cout` performs formats its output.
- Managing these flags individually is tedious and painful!

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iomanip

- `iomanip` is a collection of **input manipulators** that make working with cout easier.
- To use `iomanip` you have to include it:
  `#include <iomanip>`
- Go ahead and add this to `fahrenheit.cpp`

Setting the Field Width

- Most io manipulators are used inline with insertion operators.
- One very handy manipulator is `setw`, which sets the width of the next filed.
- For example, modify the fahrenheit program's line which displays the temperatures:

```
//display the values
cout << setw(10) << f << "  "
     << setw(7) << c << endl;
```

- Test and run your programs. See if you can guess why I selected the numbers 10 and 7.

Number Formatting

- The precision of floating point number displays is controlled using the `set_precision` function.
- In default or normal mode, precision indicates the maximum total number of digits displayed.
- In `fixed` mode, precision indicates the number of digits to the right of the decimal point.
- Once set, the numeric mode remains in effect until it is changed.
- Just before your loop in `fahrenheit.cpp` add the following:

```
//set up number format
cout << fixed << setprecision(2);
```

- Compile and test your program. Isn't that nice?

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Week 4 Lab Requirements

For full credit, your week 4 lab directory should contain:

1. A fully corrected `proportions.cpp`
2. `stock.cpp` with working menu messages.
3. `count.cpp` using the increment operator.
4. `count2.cpp`
5. `fahrenheit.cpp`