CSC 211: Computer Programming

Loops (while, do while) and nested loops

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THINK BIG WE DO℠

Original design and development by Dr. Marco Alvarez

the `while` loop

Flowchart of `while` statement

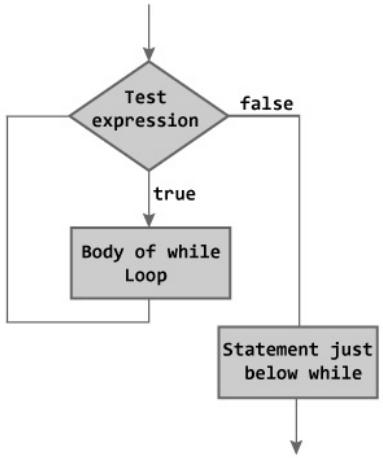


Figure: Flowchart of while Loop

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

while (test_expression) {
    // body of while
}

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

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 = 2023;

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

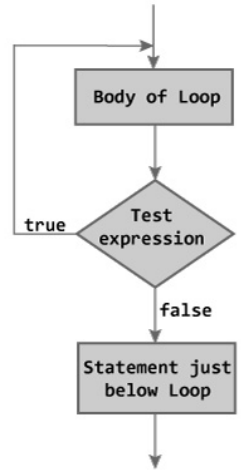

Question

- Write a single while loop to print the powers of two from 2^0 to 2^{16}.
- No cmath allowed!

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

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

Flowchart of `do-while` statement




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

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

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

Figure: Flowchart of do...while Loop

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**

```
while (test expression) {
    statement/s
    if (test expression) {
        break;
    }
    statement/s
}
```

```
do {
    statement/s
    if (test expression) {
        break;
    }
    statement/s
}
while (test expression);
```

```
for (intial expression; test expression; update expression) {
    statement/s
    if (test expression) {
        break;
    }
    statements/
}
```

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**

```
while (test expression) {
    statement/s
    if (test expression) {
        continue;
    }
    statement/s
}
```

```
do {
    statement/s
    if (test expression) {
        continue;
    }
    statement/s
}
while (test expression);
```

```
for (intial expression; test expression; update expression) {
    statement/s
    if (test expression) {
        continue;
    }
    statements/
}
```

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;
        std::cout << i << " ";
    } 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)

$F_0 = 0$
$F_1 = 1$
$F_n = F_{n-1} + F_{n-2}$

Nested loops

Question

- Output the following pattern using a single loop

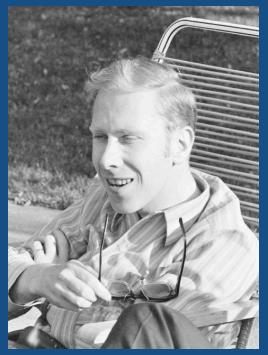
```
++++++++++
++++++++++
++++++++++
++++++++++
++++++++++
```


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 << '+';          inner loop
    }
    std::cout << std::endl;
}
```

"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::cout << '+';
    }
    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 that outputs all prime numbers from 1 to 100