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

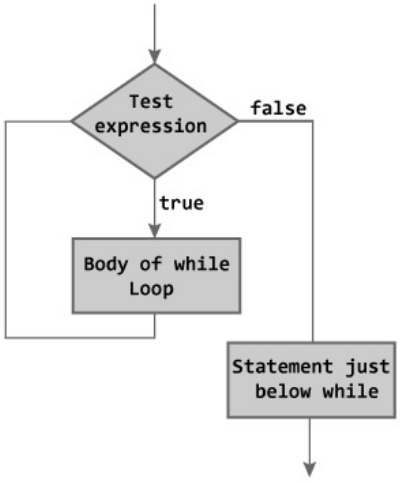


Figure: Flowchart of while Loop

```
// ...
// 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!

What is the output?

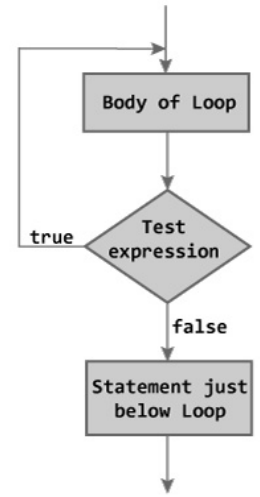
```
int main() {
    int n, i = 0;

    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




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

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

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

Figure: Flowchart of do...while Loop

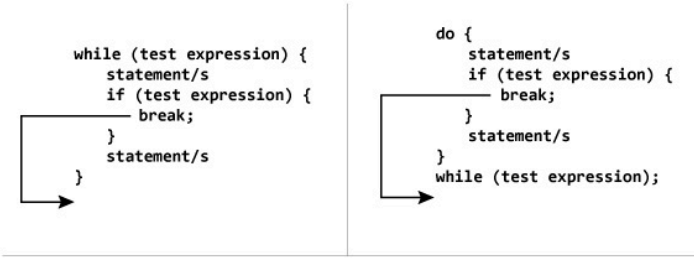
https://www.programiz.com/cpp-programming/do-while-loop

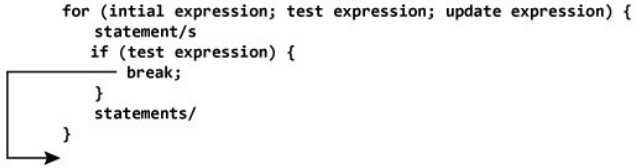
Example

```
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**





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 …

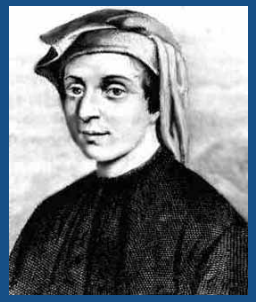
https://techterms.com/definition/rendering

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 …

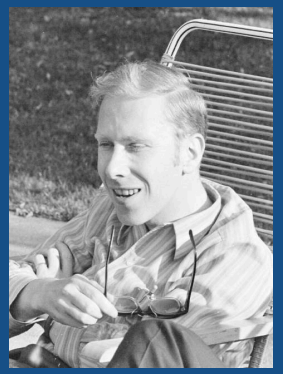
- **Nested loops**: loops inside loops

outer loop

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