Slide 1

CSC 211: Computer Programming
Loops (while, do while) and nested loops

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THINK BIG ● WE DO℠

Slide 2

the `while` loop

Slide 3

Flowchart of `while` statement


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

while (test_expression) {
    // body of while
}

// ...
// statements below
// ...
```
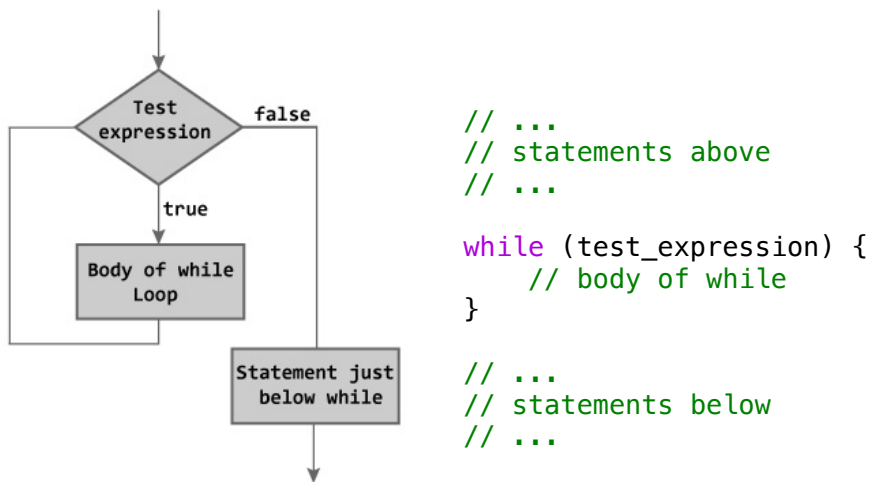
Figure: Flowchart of while Loop

Slide 4

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
```

What is the output?

```cpp
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?

```cpp
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
// ...
```

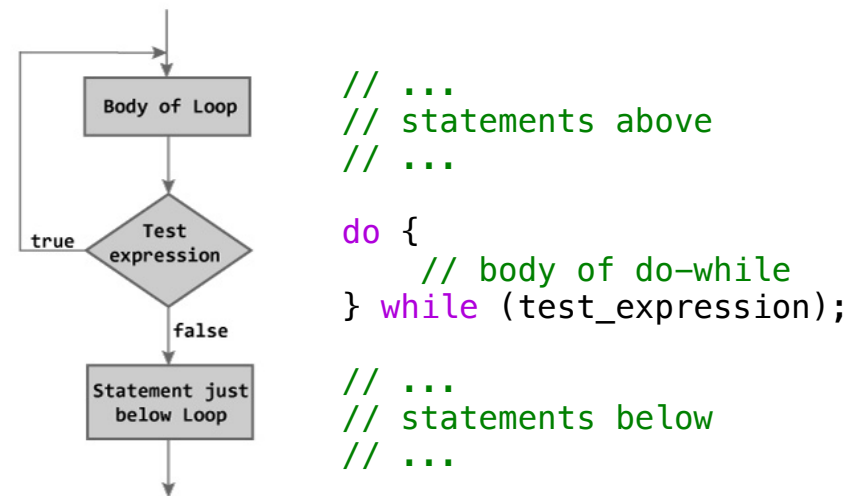Figure: Flowchart of do...while Loop

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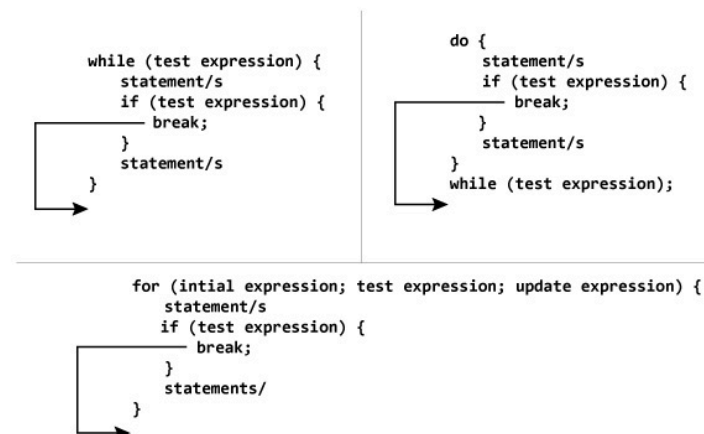## Example

```cpp
int num;

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

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

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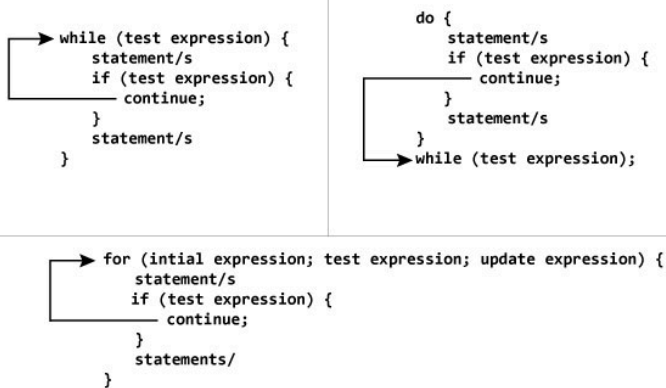
‣ The `break` statement will cause an **immediate exit**


```
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.

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`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.

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What is the output?

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

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

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Loops everywhere …

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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**.

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`

```cpp
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.

What is the output?

```cpp
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
```
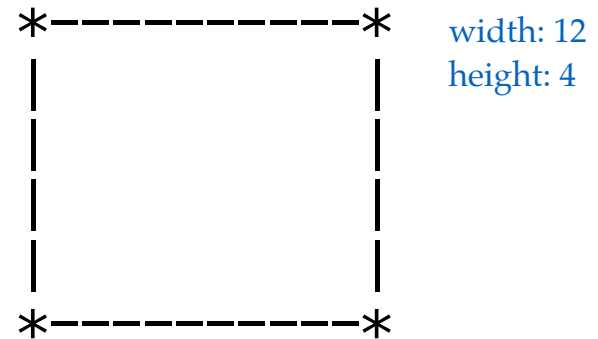
Question

- Output the following pattern using nested loops

```cpp
int rows = 5;
for(int i = 1; i <= rows; ++i)
{
    for(int j = 1; j <= i; ++j)
    {
        std::cout << j << " ";
    }
    std::cout << "\n";
}
```

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