Chapter 4: Control structures

Repetition

Loop Statements

After reading and studying this Section, student should be able to

- Implement repetition control in a program using while statements.
- Implement repetition control in a program using do-while statements.
- Implement a generic loop-and-a-half repetition control statement
- Implement repetition control in a program using for statements.
- Nest a loop repetition statement inside another repetition statement.
- Choose the appropriate repetition control statement for a given task

Definition

- Repetition statements control a block of code to be executed for a fixed number of times or until a certain condition is met.
- There are three types of repetition:
  - Count-controlled repetitions terminate the execution of the block after it is executed for a fixed number of times.
  - Sentinel-controlled repetitions terminate the execution of the block after one of the designated values called a *sentinel* is encountered.
  - Flag-controlled repetitions terminate the execution of the block after one of the designated values called a *sentinel* is encountered.
- Repetition statements are called loop statements also.

The while Statement

```
int sum = 0, number = 1;

while ( number <= 100 ) {

   sum    =  sum + number;

   number = number + 1;

}
```

These statements are executed as long as number is less than or equal to 100.

Syntax for the while Statement

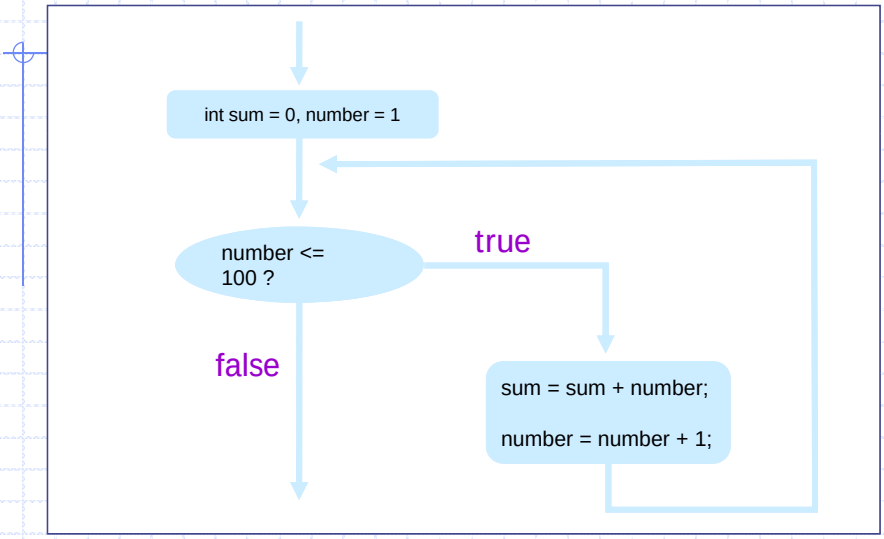
```
while ( <boolean expression> )
    <loop body>
```

Boolean Expression

```
while (  number <= 100  ) {
    sum    =  sum + number;
    number = number + 1;
}
```

loop body

Control Flow of while



More Examples

1

```
int sum = 0, number = 1;

while ( sum <= 1000000 ) {
     sum    =  sum + number;
     number = number + 1;
}
```

Keeps adding the numbers 1, 2, 3, … until the sum becomes larger than 1,000,000.

2

```
int product =  1, number = 1,
    count   = 20, lastNumber;

lastNumber = 2 * count - 1;

while (number <= lastNumber) {
     product = product * number;
     number  = number + 2;
}
```

Computes the product of the first 20 odd integers.

Loop Logical Errors

- Goal: Execute the loop body 10 times.

1

```
count = 1;
while ( count < 10 ){
    . . .
    count++;
}
```

✗

2

```
count = 1;
while ( count <= 10 ){
    . . .
    count++;
}
```

✓

3

```
count = 0;
while ( count <= 10 ){
    . . .
    count++;
}
```

✗

4

```
count = 0;
while ( count < 10 ){
    . . .
    count++;
}
```

✓

1 and 3 exhibit off-by-one error.

The do-while Statement

```
int sum = 0, number = 1;

do {
  sum += number;
  number++;
} while ( sum <= 1000000 );
```

These statements are executed as long as sum is less than or equal to 1,000,000.

Syntax for the do-while Statement

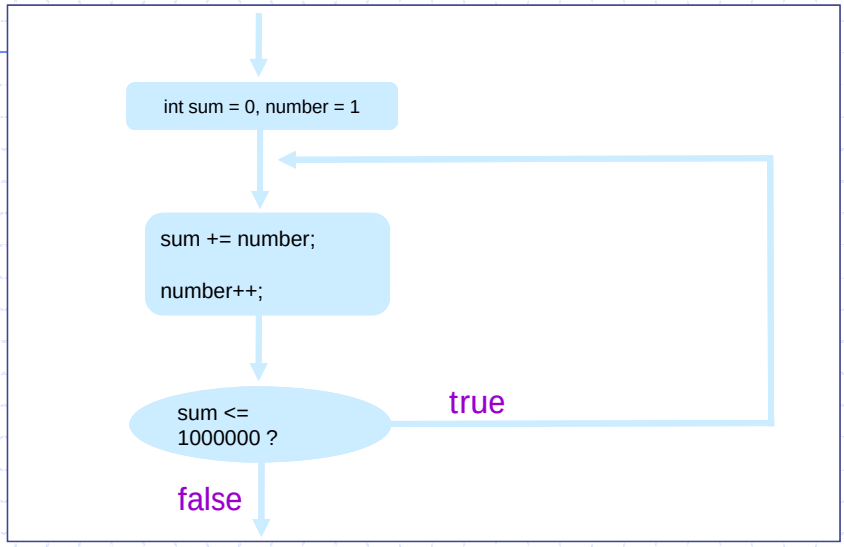
```
do
   <loop body>

while ( <boolean expression> ) ;
```

```
do  {
   sum += number;
   number++;
}  while (  sum <= 1000000  );
```

loop body

Boolean Expression

Control Flow of do-while



The for Statement

```
int i, sum = 0, number;

for (i = 0; i < 20; i++) {
  number = scanner.nextInt( );
  sum += number;
}
```

These statements are executed for 20 times (i = 0, 1, 2, … , 19).

Syntax for the for Statement

```
for ( <initialization>; <boolean expression>; <increment>  )

                <loop body>
```

Initialization

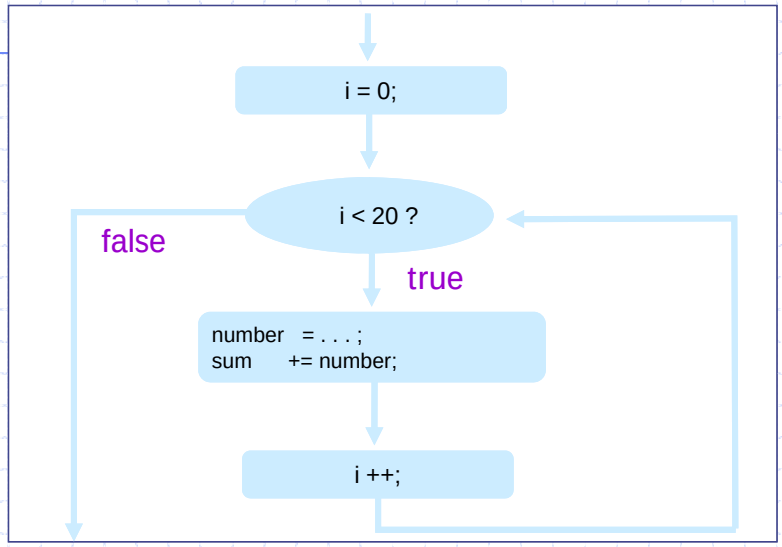
Boolean Expression

Increment / Decrement

```
for (   i = 0   ;   i < 20   ;   i++     ) {

   number = scanner.nextInt();
   sum += number;
}
```

loop body

Control Flow of for



More for Loop Examples

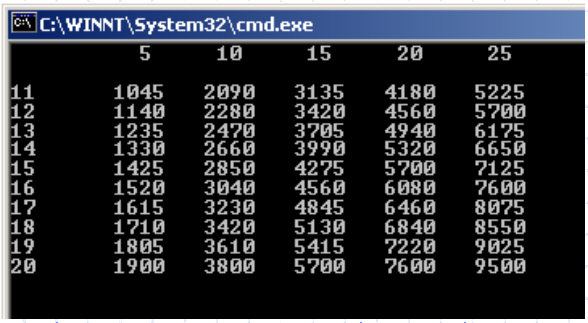
1.
```
for (int i = 0; i < 100; i += 5)
```
i = 0, 5, 10, ... , 95

2.
```
for (int j = 2; j < 40; j *= 2)
```
j = 2, 4, 8, 16, 32

3.
```
for (int k = 100; k > 0; k--) )
```
k = 100, 99, 98, 97, ..., 1

The Nested-for Statement

- Nesting a for statement inside another for statement is commonly used technique in programming.
- Let's generate the following table using nested-for statement.



Generating the Table

```
int price;
for (int width = 11; width <=20, width++){

   for (int length = 5, length <=25, length+=5){

     price = width * length * 19; //$19 per sq. ft.
     System.out.print ("  " + price);
   }
   //finished one row; move on to next row
   System.out.println("");
}
```

OUTER

INNER