# Introduction to Repetition Statements

## Syntaxes of repetition statements

Q: [What are three types of repetition statements in C++?](#three_repetition_statements)

Q: [What is syntax of while-statement?](#syntax_while_statement)

Q: [What is syntax of for-statement?](#syntax_for_statement)

Q: [What is syntax of do-while statement?](#syntax_do_while_statement)

Q: [Imagine conditions in repetition statements as a door guard?](#door_guard)

Q: [What is minimum and maximum number of times of running loop-body of while- or for-statement?](#min_max_num_for_while_statement) Q: [What is minimum and maximum number of times of running loop-body of do-while statement?](#min_max_num_do_while_statement)

Q: [What to put in loop body?](#what_in_loop_body)

## Common Mistakes of Repetition Statements

Q: Can we add a semicolon after while-head?

Q: Can we omit ; in a do-while statement?

Q: What if we forget to upload loop-variable in loop-body?

## Track Repetition Statement

Q: Given a repetition statement, how to “spread out” to test its running?

## Examples of repetition statements

Q: Starting with $10,000, how many years until we have at least $20,000, at 5% interest?

Q: Given a string, how to construct a string that contains only even-index letters?

Q: How to enter salaries (-1 to stop), then calculate their average?

Q: How to ensure a user enter an integer in [0, 100]?

## Processing input

**Q: What are three types of repetition statements in C++?**

A: while-, for-, and do-while statements.

**Q: What to put in loop body?**

A: Normally we do notput asemicolon (;)right after while-head unless we are absolutely sure that we do not need to do anything in loop-body (but then update loop variable should be put in while-head. Update loop variable should be somewhere inside the loop, if it is not inside the loop body, then it is in loop head).

For example, we have the following do-while statement, which skips all spaces until a non-space character is read (assume there is at least one char to be read).

char ch;

do {

    cin >> ch;

} while (ch == ' '); //use ; to end do-while statement

The above statement can be rewritten as follows.

char ch;

cin >> ch;

while (ch == ' ')

    cin >> ch;

The above statement can be rewritten as follows.

char ch;

while (cin >> ch && ch >= '1' && ch <= '9')

    ;

Suppose we have a few digits before a non-digit character.

|  |  |
| --- | --- |
| input 123\* | Condition (cin >> ch && ch >= '1' && ch <= '9') |
| 123\* | ch is set to be '1', condition is true, enter loop, do nothing; |
| 123\* | ch is set to be '2', condition is true, enter loop, do nothing; |
| 123\* | ch is set to be '3', condition is true, enter loop, do nothing; |
| 123\* | ch is set to be '\*', condition is false, **exit loop** |

Outside the loop, print out the current value of ch, which is '\*'.

**Q: What is syntax of while-statement?**

A: while-statement has three parts: initialization, while-head, and while-body.

initialization loop variable;

while (condition)

{

statements-to-repeat;

}

1. Loop variable is used in condition and/or statements inside the loop to decide when to stop.
2. Initialization of loop variable is not formally a part of while-statement, but its importance cannot be omitted. The initial value of loop variable decides whether the loop is entered and/or how many rounds statements-to-repeat will run.
3. Keyword while followed by condition is called while-head. The condition must be enclosed in a pair of parentheses.
4. Statements-to-repeat is also called loop body. If loop body has only one statement, curly braces { and } are NOT needed; otherwise, use a pair of { and } to enclose loop-body (it is like to use a rubber band to tie statements together).
5. while-head and while-body (i.e., loop-body) together make a while-statement. Do not put semicolon between while-head and while-body unless you are sure that while-body is an empty statement, that is, do nothing in loop body.

**Q:** **What is syntax of for-statement?**

A: for-statement is another way of writing while-statement. Unlike while-statement, for-statement formally introduce initialization of loop variable as a part of for-head. Here is its syntax.

for (initialize loop variable; condition; update loop variable)

{

statements-to-repeat;

}

The above for-statement can be rewritten as while-statement as follows; however, update of loop variable must run after statements-to-repeat. In while-statement, update of loop variable can be anywhere (beginning, middle, or bottom) of the loop.

initialize loop variable;

while (condition)

{

statements-to-repeat;

update loop variable;

}

for-statement is a concise way of writing while-statement. In general, it is used in situations where number of repetitions is known in advance. For example, do something for n times, where n can be a constant (a fixed number) or an int variable.

**Q:** **What is syntax of do-while statement?**

A: The syntax of do-while statement is as follows.

do {

statements-to-repeat;

} while (condition);

Warning: semicolon (;) ends do-while statement and cannot be omitted.

The main difference between while- (also for-) versus do-while statement is, when entering loop **for the first time**, condition is needed or not.

* Condition in while-statement is located in entry point, only when condition is true can you enter the loop.
* Condition in do-while statement is located in exit-point, first time entry is free.

The common thing among all repetition statements is, once you enter the loop, you are not free to go: you must check condition to decide whether you continue to stay inside the loop or not.

**Q: Imagine conditions in repetition statements as a door guard?**

A: Imagine condition as a door guard.

* In while- or for-statements, if condition is true, then enter the room, run codes in loop body. In do-while statement, first time entry is free.
* Once you enter the loop, exit is not free. After one round, come back to door guard again (i.e., re-evaluate condition) to see whether you can leave the room. If the condition is still true, then you stay inside the room to run one more round of codes in loop body, afterwards, come back to the door guard to check whether you can leave again …
* Hopefully, sooner or later, the condition becomes false. Then you can leave the room (i.e., exit the loop) and run the statement immediately following the loop.
  + Hence, loop body should include statement to change loop variable; otherwise, once in a loop, forever in the loop (i.e., endless loop).

**Q: What is minimum and maximum number of times of running loop-body of while- or for-statement?**

A: In while- or for-statements, the minimum number of time of running loop-body is 0, the maximum number of times of running loop-body is infinity.

**Q: What is minimum and maximum number of times of running loop-body of do-while statement?**

A: In do-while statement, the minimum number of time of running loop-body is 1, the maximum number of times of running loop-body is infinity.

**Q: What to put in loop body?**

A: Things to be repeated are put inside a loop.

Q: