Repetition Control Structure

B.Ramamurthy

Chapter 3

Introduction

- Many applications require certain operations to be carried out more than once. Such situations require repetition in control flow.
- In C++ repetition in execution can be realized using a "while", "do-while" and a "for" statement.

Topics for discussion

- Repetition structure (loop) design
- **while** loop : syntax, semantics, example
- Loop control
- **for** loop : syntax, semantics, example
- **do-while** : syntax, semantics, example
- Case Study 1
- nested loops
- Case Study 2
- Summary

while loop : syntax

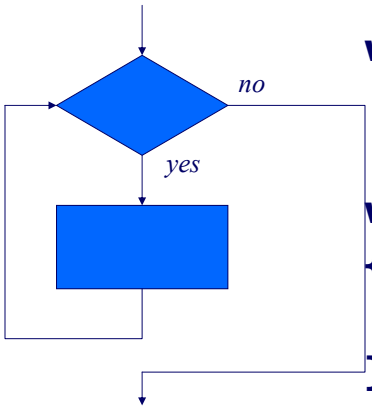
while (condition)
  statement

- "condition" is a logical expression that evaluates to true or false. It could be a relational or Boolean expression.
- "statement" could a single statement or more than one statement bounded by { }.

while loop : semantics

1) The condition is evaluated.
2) If it is true, then the body of the loop is executed. Then the **control is transferred back to the condition for re-evaluation**.
3) If the logical expression is false, the while loop is exited and control is transferred to the statement after the while statement.

The while statement



while (*condition***)**
statement;

while (*condition***)**
{
statement block
}

while loop : example

- **Problem**: Write statements to determine the sum to n natural numbers. Print out the computed sum.

```
int sum = 0;
while (n > 0)
{
   sum = sum + n;
   n = n - 1;
 }
 cout << "Sum of  first " << n << " natural numbers is " << sum
   << endl;
```


Loop Design

- **Loop design should consider:**
  - Initialization of conditions (sum = 0)
  - Termination of the loop (when n == 0)
  - Testing (at the top or bottom of the loop)
    - (at the top , n > 0)
  - Updating conditions
    - (n = n -1)
  - Of course, the body of the loop.
    - (sum = sum + n; n = n -1;)
- **Body of the loop**: Statements representing the process to be repeated. These are statements within the scope of a loop.

More about “while”

- Initialize the conditions which are evaluated in the “while”.
- Conditions are evaluated at the “top” of while statement or before the execution of the body.
- “while” body is executed 0 or more times.
- Updating of the conditions are done inside the body of the “while”.
- Use “while” when the number of times a loop is executed is dependent on some condition set during execution of the body.
  - Example: Input a list of positive number. The list is terminated by a negative number.

Example

- Write statements that takes as input n, the side of a square and print and square of size n with asterisks.

```
//PRE: n is a value between 2 and 20
//Output is for n=3
***
***
***
```

Do-while - syntax

- Use this control structure:
- When a loop needs to be executed at least once.
- When the testing of the conditions needs to be done at the bottom.

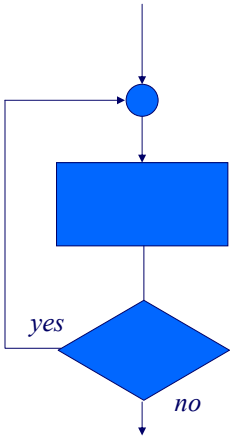
```
do
   statement
while ( condition );
```


do-while semantics

1) Execute the statement.
2) Evaluate the expression.
   If it is TRUE then proceed to step 1)
   else exit the loop.

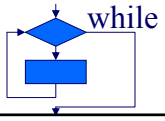
NOTE: do-while is executed at least once.

The do/while statement



do
statement;
while (*condition***)**

do
{
statement block
} while (*condition***)**



Example for do-while

Usage: Prompt user to input "month" value, keep prompting until a correct value of moth is input.

```
do
{
cout <<"Please input month {1-12}");
cin >> month;
} while ((month < 1) || (month > 12));
```

For loop - syntax

for (**initialize exp; test exp; update exp**)
statement

initialize exp : done only once at the start

test exp: This is a condition that evaluates to TRUE or FALSE.

update exp: This specifies how to update condition.

Note: for loop is used when the number of times to be repeated is fixed/known apriori.

For loop - Semantics

1) **Initialize exp** is executed.

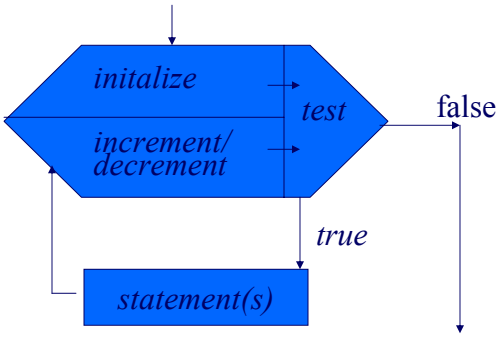
2) **Test exp** is evaluated.

If it is TRUE , body of **for** is executed

else exit **for** loop;

3) After the execution of the body of the loop, **update exp** is executed to update condition; go to Step 2 above.

The for statement



For loop - example

- Trace the execution of the "for loop" specified.

```
sum = 0;
for (i = 1; i <= n; i++)
{
    cout<< "n = " << n << "sum = "
  << sum;
   sum = sum  + n;
}
```

For - Examples

- **Problem 1**: Write a For statement that computes the sum of all odd numbers between 1000 and 2000.
- **Problem 2:** Write a For statement that computes the sum of all numbers between 1000 and 10000 that are divisible by 17.
- **Problem 3**: Printing square problem but this time make the square hollow.

Summary

- Loop design
- Repetition control structures: while, for, do-while
- Nested loops
- Beware of infinite looping problem
- Read chapter 3.