C/C++ Program Design

LAB 5

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- Master while, do-while and for loops
- Learn logical operators
- Master branching statements
- Master switch multi-branch statement
- Master the use of break and continue statements
- File operation

2 Knowledge Points

2.1 Relational Operators

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2.4 Selection Control Structure

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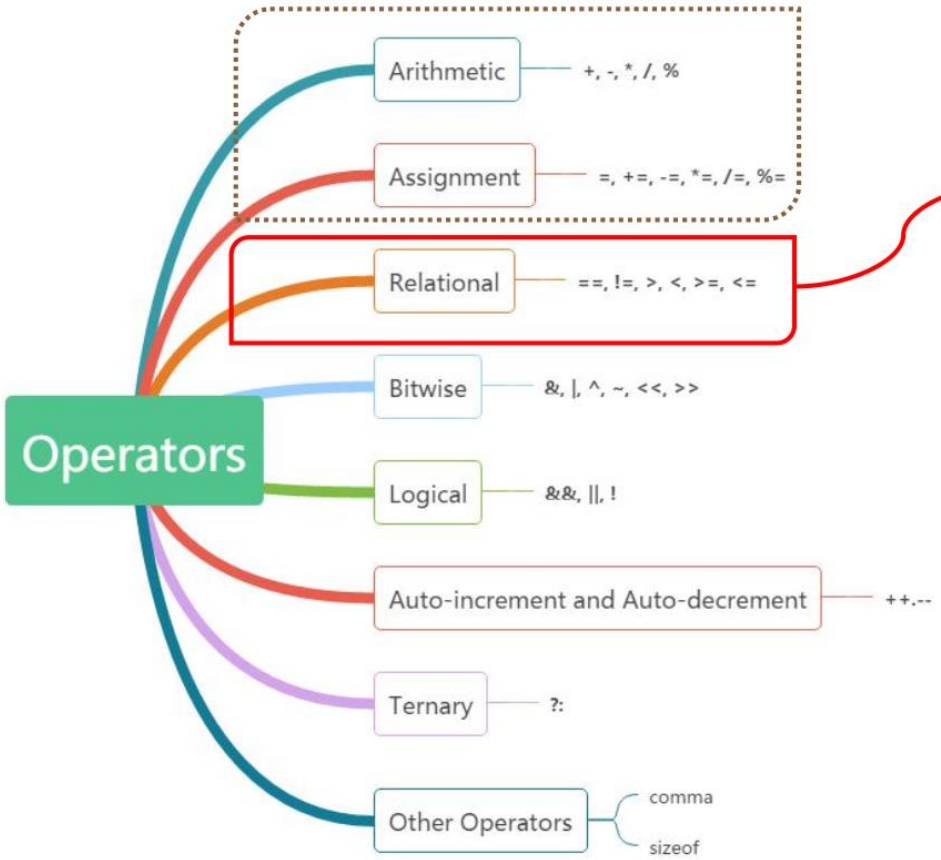
2.1 Relational operators



operator	description
==	Equal to
!=	Not equal to
<	Less than
>	Greater than
<=	Less than or equal to
>=	Greater than or equal to

Here are some examples:

```
1 (7 == 5)      // evaluates to false
2 (5 > 4)       // evaluates to true
3 (3 != 2)      // evaluates to true
4 (6 >= 6)      // evaluates to true
5 (5 < 5)       // evaluates to false
```

It's not just numeric constants that can be compared, but just any value, including, variables.

Suppose that **a=2, b=3**, and **c=6**, then:

```
1 (a == 5)      // evaluates to false, since a is not equal to 5
2 (a*b >= c)    // evaluates to true, since (2*3 >= 6) is true
3 (b+4 > a*c)   // evaluates to false, since (3+4 > 2*6) is false
4 ((b=2) == a) // evaluates to true
```

2.2 Repetition Control Structure

2.2.1 while loop

The syntax of a **while** loop is:

```
while (testExpression)
{
      // codes
}
```

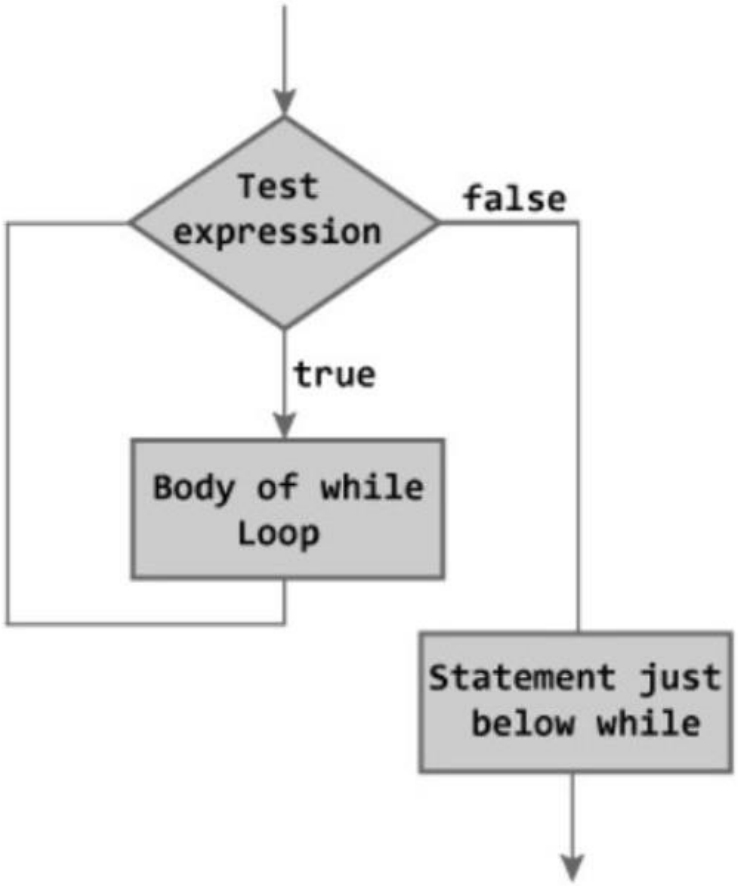


Figure: Flowchart of while Loop

Example: Compute factorial of a number.

Factorial of n = 1*2*3….*n

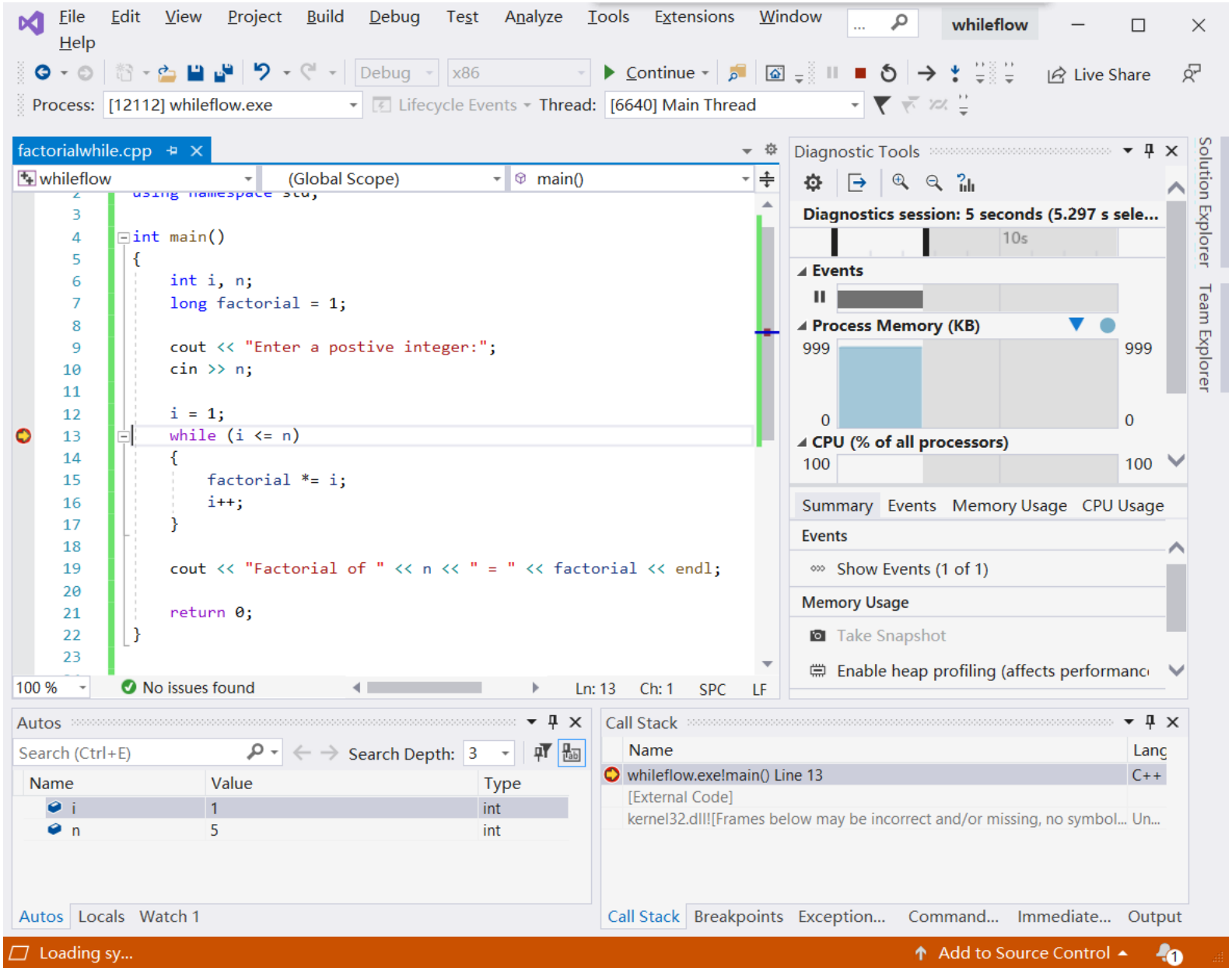
factorialwhile.cpp > main()

```cpp
#include <iostream>
using namespace std;

int main()
{
    int i, n;
    long factorial = 1;

    cout << "Enter a postive integer:";
    cin >> n;

    i = 1;
    while(i <= n)
    {
        factorial *= i;
        i++;
    }

    cout <<"Factorial of " << n << " = " << factorial << endl;

    return 0;
}
```

Sample output:

```
Enter a postive integer:5
Factorial of 5 = 120
```

You can observe the flow of the while statement by debugging your program. Set breakpoint, run the program step by step and watch the values of variables.



2.2.2 do…while loop

The syntax of a **do…while** loop is:

```
do {
    // codes;
}
while (testExpression);
```

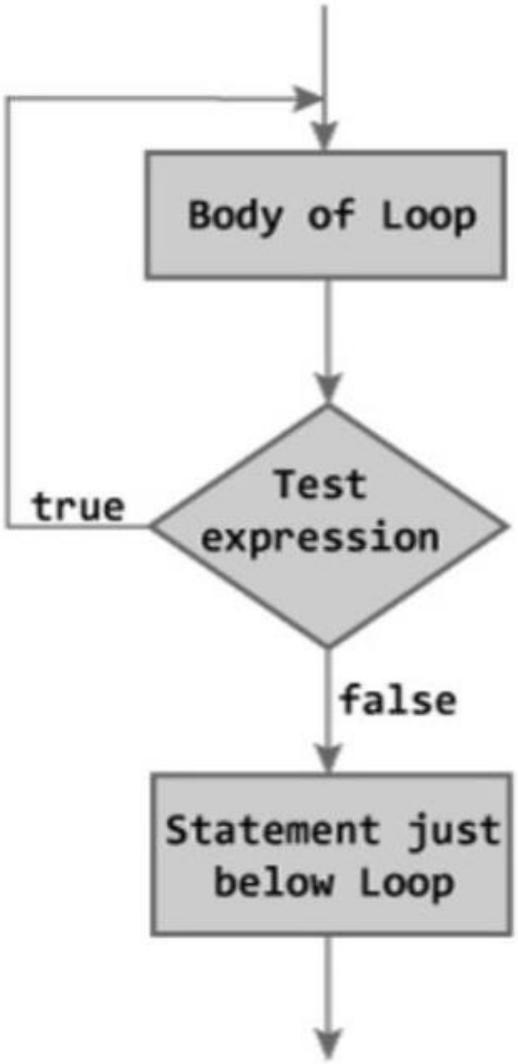


Figure: Flowchart of do...while Loop

Example: add numbers until user enters 0.

dowhile.cpp > ...

```cpp
using namespace std;

int main()
{
    float number, sum = 0.0;

    do{
        cout << "Enter a number(0 to teminate):";
        cin >> number;
        sum += number;
    }while(number != 0);

    cout << "Total sum = " << sum << endl;

    return 0;
}
```

Sample output:

```
Enter a number(0 to teminate):3.7
Enter a number(0 to teminate):-2
Enter a number(0 to teminate):9.8
Enter a number(0 to teminate):4.5
Enter a number(0 to teminate):0
Total sum = 16
```

Difference between while and do-while loop

- **while:** The loop condition is tested at the beginning of the loop before the loop is performed.
- **do-while:** The loop condition is tested after the loop body is performed. Therefore, the loop body will always execute at least once.

```
#include <iostream>
using namespace std;

int main()
{
    int n = 0;

    while(n != 0)
    {
        cout << "n:" << n << endl;
    }

    return 0;
}
```

```
#include <iostream>
using namespace std;

int main()
{
    int n = 0;

    do{
        cout << "n:" << n << endl;
    }while(n != 0);

    return 0;
}
```

Compare these two outputs

2.2.3 for loop

The syntax of a **for** loop is:

```
for(initializationStatement; testExpression; updateStatement) {
     // codes
}
```

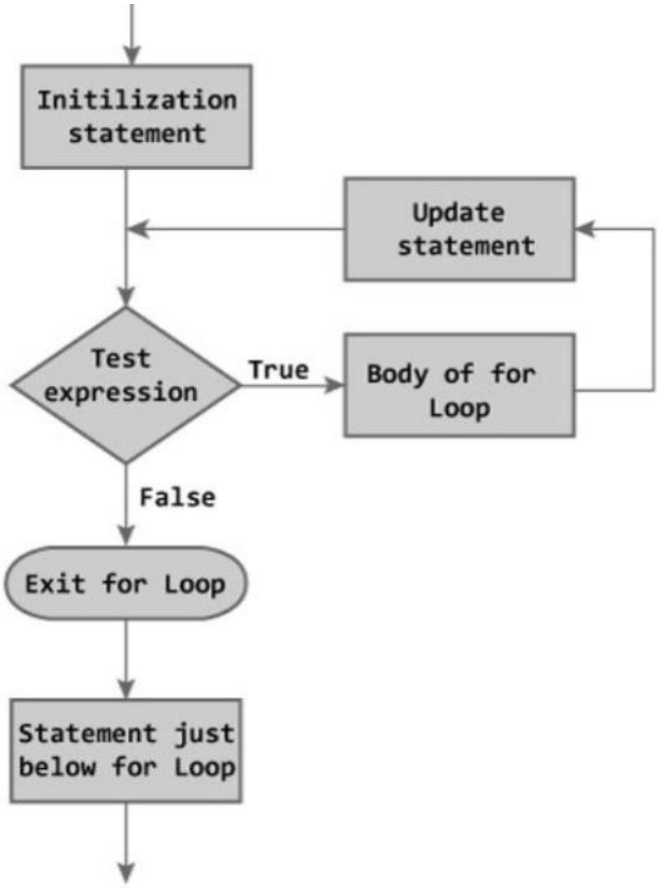


Figure: Flowchart of for Loop

Example: Compute factorial of a number.

Factorial of n = 1*2*3….*n

factorialfor.cpp > ...

```
3
4   int main()
5   {
6       int i,n;
7       long factorial = 1;
8
9       cout << "Enter a positive integer:";
10      cin >> n;
11
12      for(i = 1; i <= n; i++)
13          factorial *= i;
14
15      cout << "Factorial of " << n << " = " << factorial << endl;
16
17      return 0;
18  }
```

Sample output:

```
Enter a positive integer:5
Factorial of 5 = 120
```

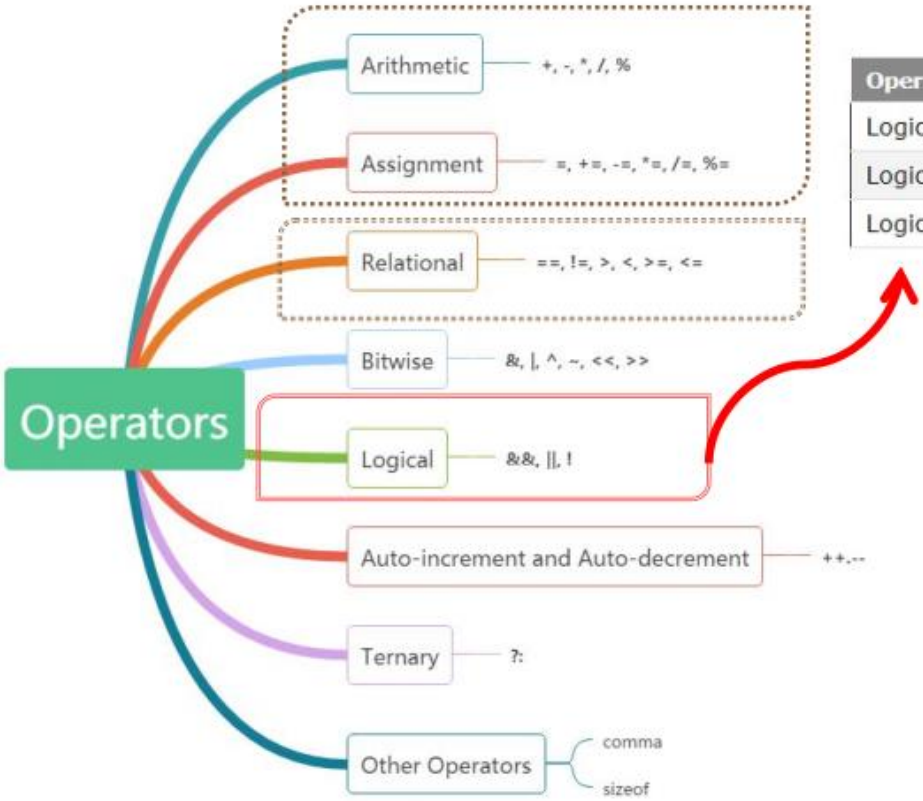
Difference between for and while loop

They can both do the same things, but in general if you know how many times you will loop, use a for, otherwise, use a while.

```
for(int i =0; i < 3; i++)
{
  // this goes around 3 times
}
```

```
bool again = true;
char ch;

while(again)
{
    cout << "Do you want to go again(Y/N)?";
    cin >> ch;
    if(ch == 'N')
        again = false;
}
```

2.3 Logical Operator



Operator	Symbol	Form	Operation
Logical NOT	!	!x	true if x is false, or false if x is true
Logical AND	&&	x && y	true if both x and y are true, false otherwise
Logical OR	||	x || y	true if either x or y are true, false otherwise

Logical Operators (!, &&, ||)

The logical operators are:

Operator	Symbol	Form	Operation
Logical NOT	!	!x	true if x is false, or false if x is true
Logical AND	&&	x && y	true if both x and y are true, false otherwise
Logical OR	||	x || y	true if either x or y are true, false otherwise

&& OPERATOR (and)

a	b	a && b
true	true	true
true	false	false
false	true	false
false	false	false

|| OPERATOR (or)

a	b	a || b
true	true	true
true	false	true
false	true	true
false	false	false

example:

```
1 !(5 == 5)    // evaluates to false because the expression at its right (5 == 5) is true
2 !(6 <= 4)    // evaluates to true because (6 <= 4) would be false
3 !true        // evaluates to false
4 !false       // evaluates to true
```

Logical NOT: !

Logical AND: &&

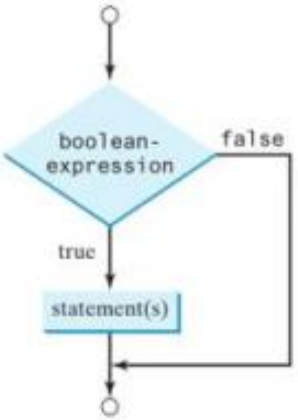
```
1 ( (5 == 5) && (3 > 6) )  // evaluates to false ( true && false )
2 ( (5 == 5) || (3 > 6) )  // evaluates to true ( true || false )
```

Logical OR: ||

2.4 Selection Control Structure

1. The syntax of the if statement

```
if(boolean-expression){
    statement(s);
}
```



sigleif.cpp > ...

```cpp
#include <iostream>
using namespace std;

int main()
{
    int n ;

    cout << "Please input an integer:";
    cin >> n;

    if(n < 100)
        cout << n << " is less than 100." << endl;

    if(n > 100)
        cout << n << " is greater than 100." << endl;

    if(n == 100)
        cout << n << " is equal to 100." << endl;

    return 0;
}
```

```
Please input an integer:45
45 is less than 100.
```

```
Please input an integer:100
100 is equal to 100.
```

```
Please input an integer:231
231 is greater than 100.
```

2. The syntax of the Nested if statement

```
if(boolean-expression1)
{
     statement1;
     if(boolean-expression2)
     {
       statement2;
     }
}
```

nestedif.cpp > ...

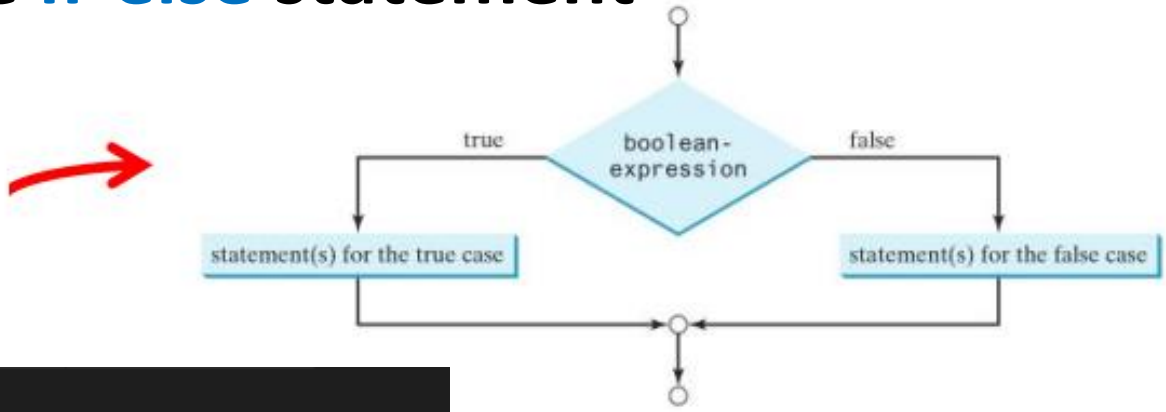
```
5   {
6       int n;
7
8       cout << "Please input an integer:";
9       cin >> n;
10
11      if(n < 100)
12      {
13          cout << n << " is less than 100, ";
14          if(n > 50)
15              cout << "but it is greater than 50." << endl;
16          if(n < 50)
17              cout << "and it is less than 50." << endl;
18      }
19
20      return 0;
21  }
```

```
Please input an integer:67
67 is less than 100, but it is greater than 50.
```

```
Please input an integer:23
23 is less than 100, and it is less than 50.
```

3. The syntax of the if-else statement

```
if (boolean-expression) {
  statement(s)-for-the-true-case;
}
else {
  statement(s)-for-the-false-case;
}
```



doublebranch.cpp > main()

```cpp
#include <iostream>
using namespace std;

int main()
{
    int n;

    cout << "Please input an integer:";
    cin >> n;

    if(n > 100)
        cout << n << " is greater than 100." << endl;
    else
        cout << n << " is equal to or less than 100." << endl;

    return 0;
}
```

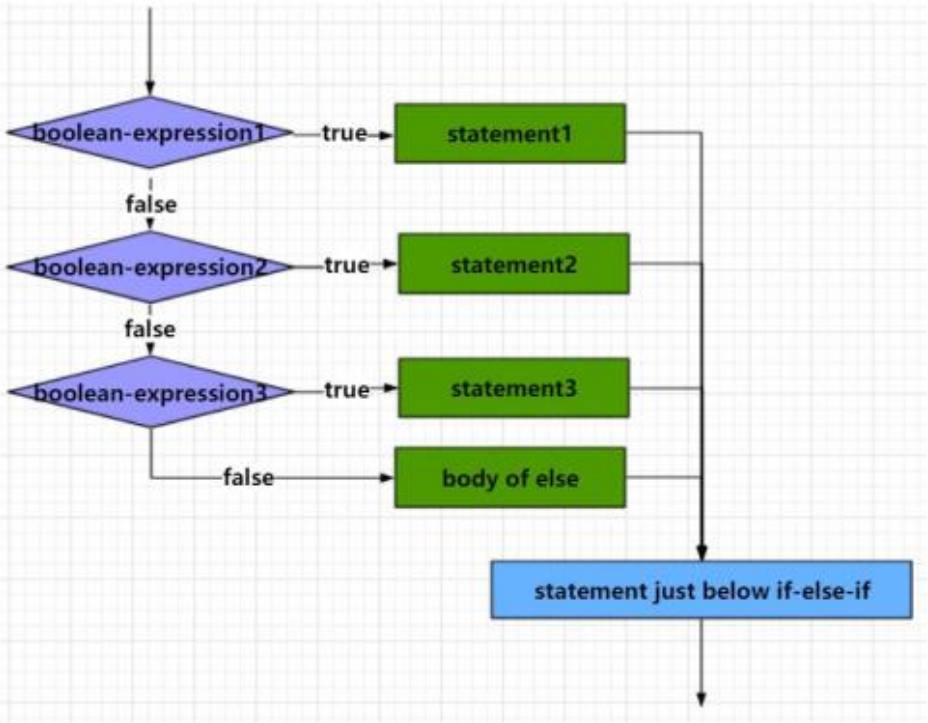
```
Please input an integer:123
123 is greater than 100.
```

```
Please input an integer:65
65 is equal to or less than 100.
```

```
Please input an integer:100
100 is equal to or less than 100.
```

4. The syntax of the if-else-if statement

```
//An if-else-if  statement can test boolean-expressions
//based on ranges of values or conditions
if (boolean-expression)
    //execute statement1
    statement1;
else if (boolean-expression)
    //execute statement2
    statement2;
...
else
    statement;
```



multibranch.cpp > ...

```cpp
#include <iostream>
using namespace std;

int main()
{
    int n;

    cout << "Please input an integer bwteen 1 and 99999:";
    cin >> n;

    if(n < 10 && n >=1)
        cout << n << " is a one digit number." << endl;
    else if(n <100 && n >= 10)
        cout << n << " is a two digit number." << endl;
    else if(n < 1000 && n >= 100)
        cout << n << " is a three digit number." << endl;
    else if(n < 10000 && n >= 1000)
        cout << n << " is a four digit number." << endl;
    else if(n <100000 && n >= 10000)
        cout << n << " is a five digit number." << endl;
    else
        cout << n << " is not between 1 and 99999." << endl;

    return 0;
}
```

```
Please input an integer bwteen 1 and 99999:23
23 is a two digit number.
```

```
Please input an integer bwteen 1 and 99999:4567
4567 is a four digit number.
```

```
Please input an integer bwteen 1 and 99999:135
135 is a three digit number.
```

```
Please input an integer bwteen 1 and 99999:23456
23456 is a five digit number.
```

Example: The Richter scale is a measurement of the strength of an earthquake.

Value	Effect
8	Most structures fall
7	Many buildings destroyed
6	Many buildings considerably damaged, some collapse
4.5	Damage to poorly constructed buildings

In this case, there are five branches: one each for the four descriptions of damage, and one for no destruction.

Use **if-else-if** statement

earthquake.cpp > main()

```cpp
#include <iostream>
using namespace std;

int main()
{
    float richter;

    cout << "Please input the richter:";
    cin >> richter;

    if(richter >= 8.0)
        cout << "Most structures fall." << endl;
    else if(richter >= 7.0)
        cout << "Many building destroyed." << endl;
    else if(richter >= 6.0)
        cout << "Many building considerably damaged, some collapse." << endl;
    else if(richter >= 4.5)
        cout << "Damage to poorly constructed buildings" << endl;
    else
        cout << "No destruction of buildings." << endl;

    return 0;
}
```

How about this program? If the input is 7, what is the output?

earthquake2.cpp > main()

```cpp
#include <iostream>
using namespace std;

int main()
{
    float richter;

    cout << "Please input the richter:";
    cin >> richter;

    if(richter >= 4.5)
        cout << "Damage to poorly constructed buildings." << endl;
    else if(richter >= 6.0)
        cout << "Many building considerably damaged, some collapse." << endl;
    else if(richter >= 7.0)
        cout << "Many building destroyed." << endl;
    else if(richter >= 8.0)
        cout << "Most structures fall." << endl;
    else
        cout << "No destruction of buildings." << endl;

    return 0;
}
```

If 7 is input to the program, what it prints?

earthquake3.cpp > main()

```cpp
#include <iostream>
using namespace std;

int main()
{
    float richter;

    cout << "Please input the richter:";
    cin >> richter;

    if(richter >= 8.0)
        cout << "Most structures fall." << endl;
    if(richter >= 7.0)
        cout << "Many building destroyed." << endl;
    if(richter >= 6.0)
        cout << "Many building considerably damaged, some collapse." << endl;
    if(richter >= 4.5)
        cout << "Damage to poorly constructed buildings" << endl;

    return 0;
}
```

if and if-else statement

```
if(opt == 1){
    //add
    result = number1+number2;
}
if(opt == 2){
    //sub
    result = number1-number2;
}
if(opt == 3){
    //multiply
    result = number1*number2;
}
if(opt == 4){
    //divide
    result = number1/number2;
}
```

It's logical fine, but it doesn't work very efficiently.

```
if(opt == 1){
    //add
    result = number1+number2;
}else if(opt == 2){
    //sub
    result = number1-number2;
}else if(opt == 3){
    //multiply
    result = number1*number2;
}else if(opt == 4){
    //divide
    result = number1/number2;
}
```

It's more efficient. Because if opt==1, then the addition is performed, but the rest of the operation are definitely not to be look at.

The Dangling else problem

When an if statement is nested inside another if statement, the ***else*** clause always matches the most recent unmatched **if** clause in the same block.

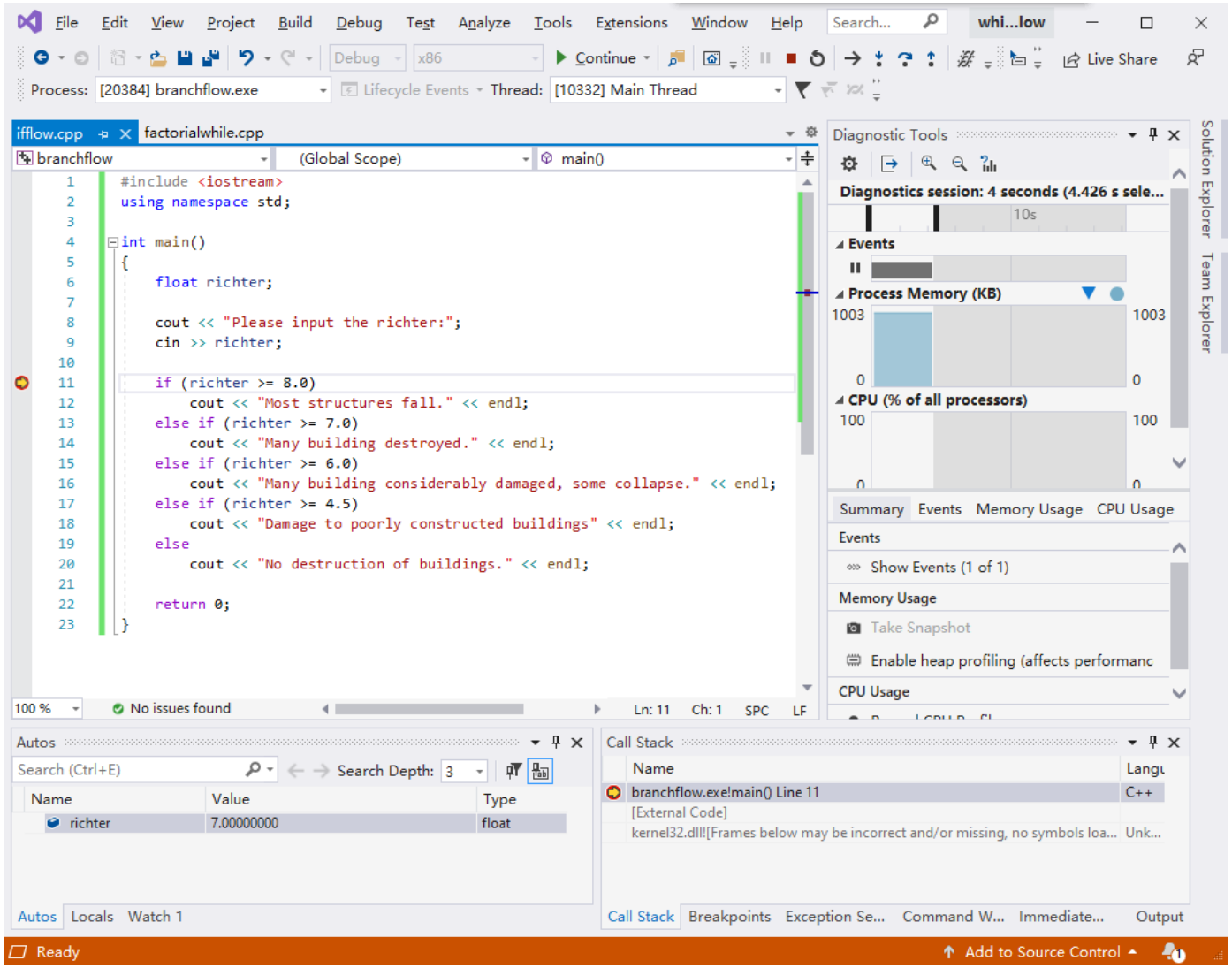
```
int i = 1;
int j = 2;
int k = 3;

if (i > j)
  if (i > k)
     System.out.println("A");
else
     System.out.println("B");
```

The complier ignores all indentation and matches the else with the preceding **if**.

To force the **else** clause to match the first ***if*** clause, you must add a pair of braces.

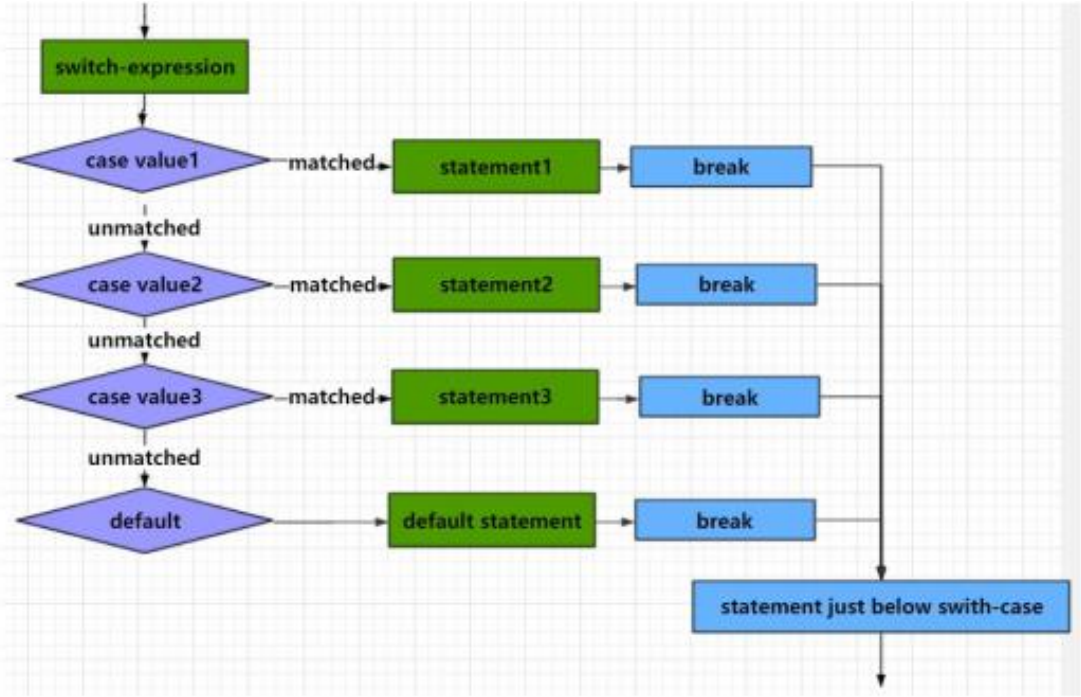
```
int i = 1, j = 2, k = 3;

if (i > j) {
  if (i > k)
     System.out.println("A");
}
else
  System.out.println("B");
```

You can observe the flow of the branch statements by debugging your program. Set breakpoint, run the program step by step and watch the values of variables. Compare the flow between if and if-else if statements.



5. The switch statement

```
// The switch-expression must yield a value
// of char,byte,short,int,or String type
switch (switch-expression)
{
  case value1:
    //execute statement1
    statement1;
    break;
  case value2:
    //execute statement1
    statement2;
    break;
  ...
  case valueN:
   //execute statementN
    statementN;
    break;
  default:
    //execute statementDefault
    statementDefault;
}
```



switchbranch.cpp > ...

```cpp
int main()
{
    int num;

    cout << "Enter an integer between 1 and 3:";
    cin >> num;

    switch(num)
    {
        case 1: cout << "Case 1." << endl;
                break;
        case 2: cout << "Case 2." << endl;
                break;
        case 3: cout << "Case 3." << endl;
                break;
        default: cout << "Default." << endl;
    }

    return 0;
}
```

```
Enter an integer between 1 and 3:1
Case 1.
```

```
Enter an integer between 1 and 3:2
Case 2.
```

```
Enter an integer between 1 and 3:3
Case 3.
```

```
Enter an integer between 1 and 3:5
Default.
```

If there is no break in the switch statement, what will happen?

switchbranch.cpp > ...

```cpp
int main()
{
    int num;

    cout << "Enter an integer between 1 and 3:";
    cin >> num;

    switch(num)
    {
        case 1: cout << "Case 1." << endl;

        case 2: cout << "Case 2." << endl;

        case 3: cout << "Case 3." << endl;

        default: cout << "Default." << endl;
    }

    return 0;
}
```

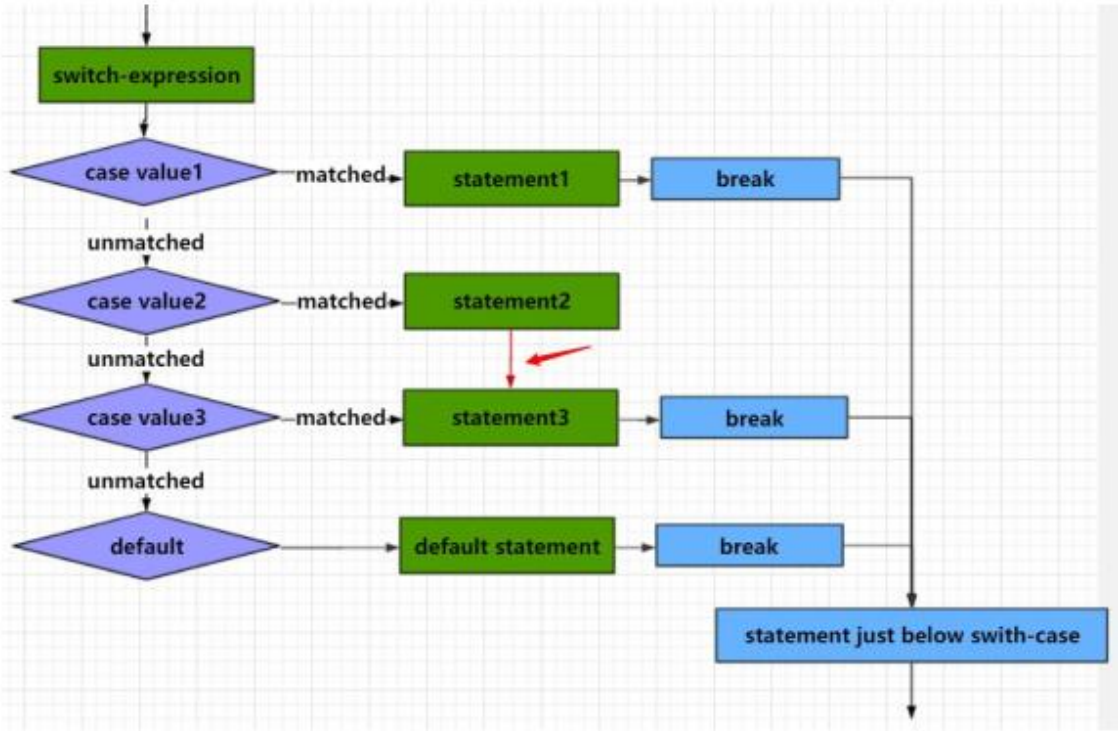
```
Enter an integer between 1 and 3:1
Case 1.
Case 2.
Case 3.
Default.
```

If the **break** statement is omitted, the output will not exit the switch

Note: switch case statement is mostly used with **break** statement.

```
switch (switch-expression)
{
  case value1:
    //execute statement1
    statement1;
    break;
  case value2:
    //execute statement1
    statement2;
    //break;
  ...
  case valueN:
   //execute statementN
    statementN;
    break;
  default:
    //execute statementDefault
    statementDefault;
}
```

If the break statement is omitted



Difference between if and switch

Piece #1

```
if(opt == 1){
    //add
    result = number1+number2;
}
if(opt == 2){
    //sub
    result = number1-number2;
}
if(opt == 3){
    //multiply
    result = number1*number2;
}
if(opt == 4){
    //divide
    result = number1/number2;
}
```

Piece #2

```
if(opt == 1){
    //add
    result = number1+number2;
}else if(opt == 2){
    //sub
    result = number1-number2;
}else if(opt == 3){
    //multiply
    result = number1*number2;
}else if(opt == 4){
    //divide
    result = number1/number2;
}
```

Piece #3

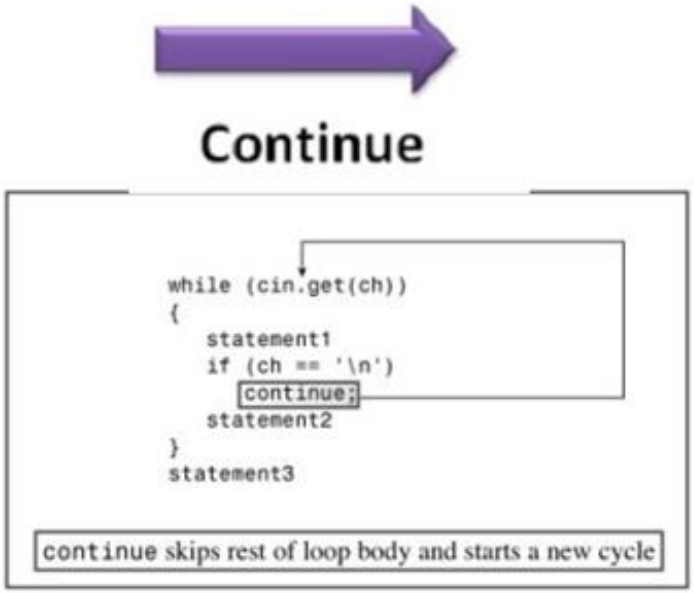
```
switch(opt){
    case 1:
        //add
        result = number1+number2;
        break;
    case 2:
        //sub
        result = number1-number2;
        break;
    case 3:
        //multiply
        result = number1*number2;
        break;
    case 4:
        //divide
        result = number1/number2;
        break;
    default:
        printf("The operator must be one of 1,2,3, and 4\n");
        return; //退出
}
```

use switch if you have three or more alternatives

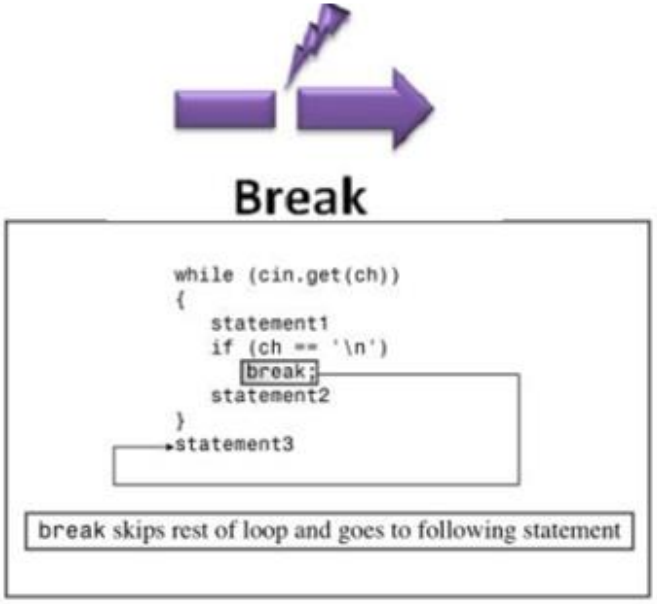
Difference between if and switch

- Check the Expression: An **if-else-if** statement can test boolean-expressions based on ranges of values or conditions, whereas a **switch** statement tests switch-expressions based only on a single int, enumerated value, byte, short, char. The **switch…case** can only judge the condition of equality, and **if** can judge any condition, such as equal, not equal, greater, less, etc.. If your alternatives involve ranges or floating-point tests or comparing two variables, you should use **if else**.
- switch case is faster than if-else: When the number of branches is large (generally larger than 5), **switch-case** is faster than **if-else-if**.
- Clarity in readability: A **switch-case** looks much cleaner than **if-else-if**.

2.5 Difference between continue and break



The structure of continue statement



The structure of break statement

The main difference is as follows:

- **break** is used for immediate termination of loop
- **continue** terminate current iteration and resumes the control to the next iteration of the loop

2.6 Simple File Input and Output

ofstream: Stream class to write on files

ifstream: Stream class to read from files

fstream: Stream class to both read and write from/to files

```
ofstream outClientFile;
```

Create an ofstream object

```
outClientFile.open("clients.txt", ios::out);
```

The ofstream member function **open** opens a file and attaches it to an existing ofstream object. **ios::out** is the default value for the second argument.

class	default mode parameter
ofstream	ios::out
ifstream	ios::in
fstream	ios::in | ios::out

File Open Modes

Mode	Description
`ios::app`	*Append* all output to the end of the file.
`ios::ate`	Open a file for output and move to the end of the file (normally used to append data to a file). Data can be written *anywhere* in the file.
`ios::in`	Open a file for *input*.
`ios::out`	Open a file for *output*.
`ios::trunc`	*Discard* the file's contents (this also is the default action for `ios::out`).
`ios::binary`	Open a file for binary, i.e., *nontext*, input or output.

Checking state flags

bad()	Returns true if a reading or writing operation fails. For example, in the case that we try to write to a file that is not open for writing or if the device where we try to write has no space left.
fail()	Returns true in the same cases as bad(), but also in the case that a format error happens, like when an alphabetical character is extracted when we are trying to read an integer number.
eof()	Returns true if a file open for reading has reached the end.
good()	It is the most generic state flag: it returns false in the same cases in which calling any of the previous functions would return true. Note that good and bad are not exact opposites (good checks more state flags at once).

The tests for successful opening a file are the following:

```
if(myfile.fail()) ... // failed to open
if(!myfile.good()) ... // failed to open
if (!myfile) ... // failed to open
if(!myfile.is_open())//failed to open
```

File-Position Pointer:

```
finout.seekg(30, ios_base::beg); // 30 bytes beyond the beginning
finout.seekg(-1, ios_base::cur); // back up one byte
finout.seekg(0, ios_base::end); // go to the end of the file
tellg()//Get the current position of a file input streams pointer
tellp()// Get the current position of a file output streams pointer
```

Writing to a text file:

writefile.cpp > ...

```cpp
#include <iostream>
#include <fstream>
using namespace std;

int main()
{
    ofstream myfile;
    myfile.open("example.txt");

    if(myfile.is_open())
    {
        cout << "Open the file for writing a string:\n";
        myfile << "This is an example of writing a string to a file.\n";
        myfile << "Hello world!\n";

        myfile.close();
    }
    else
        cout << "Can not open the file.\n";

    return 0;
}
```

Create an object of ofstream

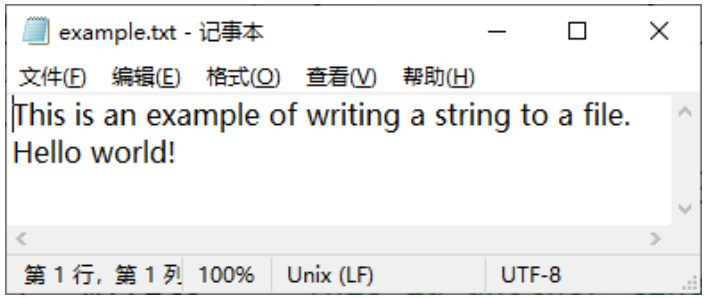
Associate the object with a file, using **open()** method

Check if the file is opened normally

Write strings to the file using **<<**

Close the file

Open the example.txt



Reading from a text file:

readfile.cpp > ...

```cpp
#include <iostream>
#include <fstream>
using namespace std;

int main()
{
    string contents;
    ifstream infile;
    infile.open("example.txt");

    if(infile.is_open())
    {
        while(!infile.eof())
        {
            getline(infile,contents);
            cout << contents << endl;
        }
        infile.close();
    }
    else
        cout << "Can not open the file.\n";

    return 0;

}
```

Create an object of ifstream

Associate the object with a file, using **open()** method

Check if the file is opened normally

Check if reaches the end of the file

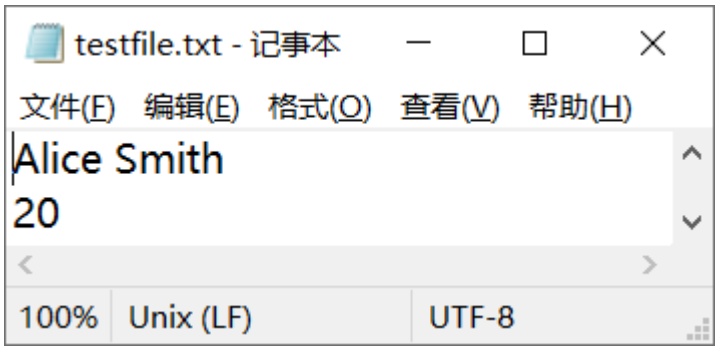
Read a line of string from the file

Close the file

```
This is an example of writing a string to a file.
Hello world!
```

File input and output

```cpp
#include <iostream>
#include <fstream>
using namespace std;

int main() {
    char input[80];
    int age;
    string readline;

    fstream finout( s: "testfile.txt", ios::in | ios::out);

    if(finout.good())
    {
        cout << "Writing to a text file:" << endl;
        cout << "Please enter your name:";
        cin.getline(input, n: 80);
        cout << "Please enter your age:";
        cin >> age;
        finout << input << endl;
        finout << age << endl;
        finout.clear();   // reset the stream state
        finout.seekg(0);

        cout << "Reading from the text file:" << endl;
        while(!finout.eof())
        {
            getline( &: finout, &: readline);
            cout << readline << endl;
        }
        finout.close();
    }
    else
        cout << "testfile.txt could not be opened.";

    return 0;
}
```



Output:

```
Writing to a text file:
Please enter your name:Alice Smith
Please enter your age:20
Reading from the text file:
Alice Smith
20
```