

Programming Design

Selection and Repetition

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Outline

- **Preprocessors and namespaces**
- Selection
- Repetition

Preprocessors and namespaces

- Recall that our first C++ program was

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

int main()
{
    cout << "Hello World! \n";
    return 0;
}
```

- Now it is time to formally introduce the first two lines.

Preprocessors

- **Preprocessor** commands, which begins with **#**, performs some actions **before** the compiler does the translation.
- The **include** command here is to include a **header** file:
 - Files containing **definitions** of common variables and functions.
 - Written to be included by other programs.

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

int main()
{
    cout << "Hello World! \n";
    return 0;
}
```

Preprocessors

- `#include <iostream>`
 - `iostream` is part of the **C++ standard library**. It provides functionalities of data input and output, e.g., `cout` and `cin`.
- Before the compilation, the compiler looks for the `iostream` header file and **copy** the codes therein to replace this line.
 - The same thing happens when we include other header files.

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

int main()
{
    cout << "Hello World! \n";
    return 0;
}
```

Including header files

- In this program, we include the **iostream** file for the **cout** object.
- With **angle brackets** (< and >), the compiler searches for “iostream” in the C++ standard library.
- We may define our own variables and functions into **self-defined header files** and include them by ourselves:
 - `#include "C:\myHeader.h" ;`
 - Use double quotation marks instead of angle brackets.
 - A path must be specified.
- We will not use self-defined header files in the first half of this semester.

Namespaces

- What is a **namespace**?
- Suppose all roads in Taiwan have different names. In this case, we do not need to include the city/county name in our address.
 - This is why we do not need to specify the district for an address in the Taipei city.
 - But we need to specify the district for an address in the New Taipei County.

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

int main()
{
    cout << "Hello World! \n";
    return 0;
}
```

Namespaces

- A C++ namespace is a **collection** (space) of **names**.
 - For C++ variables, functions, objects, etc.
 - The objects **cout**, **cin**, and all other items defined in the C++ standard library are defined in the namespace **std**.
- By writing **using namespace std;**, whenever the compiler sees a name, it searches whether it is defined in this program or the namespace **std**.

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

int main()
{
    cout << "Hello World! \n";
    return 0;
}
```


The scope resolution operator (::)

- Instead, we may specify the namespace of **cout** each time when we use it with the scope resolution operation `::`.

```
#include <iostream>

int main()
{
    std::cout << "Hello World! \n";
    return 0;
}
```

- Most programmers do not need to define their own namespaces.
 - Unless you really want to name your own variable/object as **cout**.
 - Typically a **using namespace std;** statement suffices.

Outline

- Preprocessors and namespaces
- **Selection**
 - **if-else**
 - Logical operators
 - **switch-case**
- Repetition

The `if` statement

- Last time we studied one kind of selection statement, the `if` statement.
 - `condition` returns a Boolean value.
 - `{ }` may be dropped if there is only one statement.
- In many cases, we hope that conditional on whether the condition is true or false, we do different sets of statements.
- This is done with the `if-else` statement.
 - Do `statements 1` if `condition` returns `true`.
 - Do `statements 2` if `condition` returns `false`.
- An `else` must have an associated `if`!

```
if (condition)  
{  
    statements  
}
```

```
if (condition)  
{  
    statements 1  
}  
else  
{  
    statements 2  
}
```

Example of the `if-else` statement

- The income tax rate often varies according to the level of income.
 - E.g., 2% for income below \$10000 but 8% for the part above \$10000.
- How to write a program to calculate the amount of income tax based on an input amount of income?
 - Which of the following two programs is correct (or better)?

```
int income = 0, tax = 0;

cout << "Please enter your income: ";
cin >> income;

if(income <= 10000)
    tax = 0.02 * income;
if(income > 10000)
    tax = 0.08 * (income - 10000) + 200;

cout << "Tax amount: $" << tax << "\n";
```

```
int income = 0, tax = 0;

cout << "Please enter your income: ";
cin >> income;

if(income <= 10000)
    tax = 0.02 * income;
else
    tax = 0.08 * (income - 10000) + 200;

cout << "Tax amount: $" << tax << "\n";
```

Nested if-else statement

- An **if** or an **if-else** statement can be **nested** in an **if** block.
 - In this example, if both conditions are true, statements A will be executed.
 - If condition 1 is true but condition 2 is false, statements B will be executed.
 - If condition 1 is false, statements C will be executed.
- An **if** or an **if-else** statement can be nested in an **else** block.
- We may do this for any level of **if** or **if-else**.

```
if(condition 1)
{
    if(condition 2)
    {
        statements A
    }
    else
    {
        statements B
    }
}
else
{
    statements C
}
```

Example of nested `if-else` statements

- Given three integers a , b , and c , how to find the smallest one?
- Nested **if-else** is helpful:
- Some questions:
 - What will happen if there are multiple smallest values?
 - May we drop the two pairs of curly brackets?

```
int a = 0, b = 0, c = 0;
cin >> a >> b >> c;

if(a <= b)
{
    if(a <= c)
        cout << a << " is the smallest\n";
    else
        cout << c << " is the smallest\n";
}
else
{
    if(b <= c)
        cout << b << " is the smallest\n";
    else
        cout << c << " is the smallest\n";
}
```

Two different implementations

```
int min = 0;
if(a <= b)
{
    if(a <= c)
        min = a;
    else
        min = c;
}
else
{
    if(b <= c)
        min = b;
    else
        min = c;
}
cout << min << " is the smallest";
```

```
int min = c;
if(a <= b)
{
    if(a <= c)
        min = a;
}
else
{
    if(b <= c)
        min = b;
}
cout << min << " is the smallest";
```

- Good? Bad?

The ternary if operator ? :

- In many cases, what to do after an **if-else** selection is simple.
- The **ternary if operator ? :** can be helpful in this case.

condition ? *operation A* : *operation B*

– If *condition* is true, do *operation A*; otherwise, *operation B*.

- Let's modify the previous example:

```
if(a <= b)
  a <= c ? min = a : min = c;
else
  min = b <= c ? b : c;
```


The ternary if operator ? :

- **Parentheses are helpful** (though not needed):

```
if(a <= b)
    (a <= c) ? (min = a) : (min = c);
else
    min = (b <= c ? b : c);
```

- Ternary if operators can also be nested (but **not suggested**):

```
min = a <= b ? a <= c ? a : c : b <= c ? a : c;
```

```
min = (a <= b ? (a <= c ? a : c) : (b <= c ? a : c));
```

Dangling if-else

- What does this mean?

```
if(a == 10)
    if(b == 10)
        cout << "a and b are both ten.\n";
else
    cout << "a is not ten.\n";
```

- In the current C++ standard, it is actually:

```
if(a == 10)
{
    if(b == 10)
        cout << "a and b are both ten.\n";
    else
        cout << "a is not ten.\n";
}
```

Dangling `if-else`

- When we drop `{ }`, our programs may be grammatically ambiguous.
- In the field of Programming Languages, it is called **the dangling problem**.
- To handle this, C++ defines that “one **else** will be paired to the **closest if** that has **not** been paired with an **else**.”
- Good programming style:
 - Drop `{ }` only when you know what you are doing.
 - Align your `{ }`.
 - Indent your codes properly.

The `else-if` statement

- An **if-else** statement allows us to respond to a binary condition.
- When we want to respond to a ternary condition, we may put an **if-else** statement in an **else** block:
- For this situation, people typically drop `{ }` and put the second **if** behind **else** to create an **else-if** statement:

```
if(a < 10)
    cout << "a < 10.";
else
{
    if(a > 10)
        cout << "a > 10.";
    else
        cout << "a = 10.";
}
```

```
if(a < 10)
    cout << "a < 10.";
else if(a > 10)
    cout << "a > 10.";
else
    cout << "a = 10.";
```

The `else-if` statement

- An **else-if** statement is generated by using two nested **if-else** statements.
- It is logically fine if we do not use **else-if**.
- However, if we want to respond to more than three conditions, using **else-if** greatly enhances the **readability** of our program.
- Another selection statement, **switch-case**, is (sometimes) more appropriate for a condition that has many realizations and will be introduced later.

```
if(month == 1)
    cout << "31 days";
else if(month == 2)
    cout << "28 days";
else if(month == 3)
    cout << "31 days";
else if(month == 4)
    cout << "30 days";
else if(month == 5)
    cout << "31 days";
// ...
else if(month == 11)
    cout << "30 days";
else
    cout << "31 days";
```

Outline

- Preprocessors and namespaces
- **Selection**
 - **if-else**
 - **Logical operators**
 - **switch-case**
- Repetition

Logical operators

- In some cases, the condition for an **if** statement is complicated.
 - If I love a girl **and** she also loves me, we will fall in love.
 - If I love a girl **but** she does not love me, my heart will be broken.
- We may use **logical operators** to combine multiple conditions.
- We have three logical operators:
 - **&&**: and.
 - **||**: or.
 - **!**: not.
- These operators have their aliases (**and**, **or**, and **not**). For the aliases of many operators, see http://en.wikipedia.org/wiki/Operators_in_C_and_C%2B%2B.

Logic operators: and

- The “and” operator operates on **two conditions**.
 - Each condition is an operand.
- It returns true if **both** conditions are true. Otherwise it returns false.
 - `(3 > 2) && (2 > 3)` returns **false**.
 - `(3 > 2) && (2 > 1)` returns **true**.
- When we use it in an **if** statement, the grammar is:

```
if(condition 1 && condition 2)  
{  
    statements  
}
```


Logic operators: and

- An “and” operation can replace a nested **if** statement.

– The nested **if** statement

```
if(a >= 10)
{
    if(a <= 20)
        cout << "a is between 10 and 20;";
}
```

is equivalent to

```
if(a >= 10 && a <= 20)
    cout << "a is between 10 and 20;";
```

- Each of the two conditions must be complete by itself.

```
if(a >= 10 && <= 20) // error!
    cout << "a is between 10 and 20;";
```

- Two conditions can be combined only with a logical operator

```
if(10 <= a <= 20) // error!
    cout << "a is between 10 and 20;";
```

Logic operators: or

- The “or” operator returns true if **at least** one of the two conditions is true. Otherwise it returns false.
 - `(3 > 2) || (2 > 3)` returns **true**.
 - `(3 < 2) || (2 < 1)` returns **false**.
- When the or operator is used in an **if** statement, the grammar is

```
if(condition 1 || condition 2)  
{  
    statements  
}
```

Logic operator: not

- The “not” operator returns the **opposite** of the condition.
 - `!(2 > 3)` returns **true**.
 - `!(2 > 1)` returns **false**.
- It is used when we have statements only in the **else** block:
 - The following two programs are equivalent:

```
if(condition)  
    ;  
else  
{  
    statements  
}
```

```
if(!condition)  
{  
    statements;  
}
```

Associativity and precedence

- The **&&** and **||** operators both **associate** the two conditions **from left to right**.
- It is possible that the second condition is not evaluated at all.
 - If evaluating the first one is enough.
- What will be the outputs?
- There is a **precedence** rule for operators.
 - You may find the rule in the textbook.
 - You do not need to memorize them: Just use **parentheses**.

```
int a = 0, b = 0;

if((a > 10) && (b = 1))
    ;
cout << b << "\n";

if((a > 10) || (b = 5))
    ;
cout << b << "\n";
```

Outline

- Preprocessors and namespaces
- **Selection**
 - **if-else**
 - Logical operators
 - **switch-case**
- Repetition

The switch-case statement

- The second way of implementing a selection is to use a **switch-case** statement.
 - It is particularly useful for responding to **multiple** values of a single operation.
- For the *operation*:
 - It can contain only a single operand.
 - It must return an **integer**.

```
switch(operation)
{
    case value 1:
        statements
        break;
    case value 2:
        statements
        break;
    ...
    default:
        statements
        break;
}
```

The switch-case statement

- After each **case**, there is a **value**.
 - If the returned value of the operation equals that value, those statements in the case block will be executed.
 - No curly brackets are needed for blocks.
 - A **colon** is needed after the value.
- A **break** marks **the end of a block**.
 - The **break** of the last section is optional.
- Restrictions on those values:
 - Cannot be (non-constant) variables.
 - Must be different integers.

```
switch(operation)
{
  case value 1:
    statements
    break;
  case value 2:
    statements
    break;
  ...
  default:
    statements
    break;
}
```

The break statement

- What will happen if we enter 10?

```
int a;
cin >> a;

switch(a)
{
    case 10:
        cout << "ten";
        break;
    case 6:
        cout << "six";
        break;
}
```

```
int a;
cin >> a;

switch(a)
{
    case 10:
        cout << "ten";
    case 6:
        cout << "six";
        break;
}
```

- Dropping a **break** may be useful:

```
char a;
cin >> a;

switch(a)
{
    case 'c':
    case 'C':
        cout << "c or C.";
}
```


The default block

- The **default** block will be executed if no **case** value matches the operation's return value.
- You may add a **break** at the end of **default** or not. It does not matter.

```
int a;
cin >> a;

switch(a)
{
    case 10:
        cout << "a is ten.";
        break;
    case 20:
        cout << "a is twenty.";
        break;
    default:
        cout << a << "\n";
}
```

An example

- Given a year and a month, how many days is in that month?
- There are four possibilities:
 - 31 days: January, March, May, July, August, October, December.
 - 30 days: April, June, September, November.
 - 29 days: February in a leap year.
 - 28 days: February in an ordinary year.
- A year is a leap year if:
 - It is a multiple of 400, or
 - It is a multiple of 4 but not a multiple of 100.

Two implementations

```
int y = 0, m = 0;
cin >> y >> m;
int d = 0;

if(m == 1 || m == 3 || m == 5 || m == 7 ||
    m == 8 || m == 10 || m == 12)
    d = 31;
else if(m == 4 || m == 6 ||
        m == 9 || m == 11)
    d = 30;
else if((y % 400 == 0) ||
        (y % 4 == 0 && (y % 100 != 0)))
    d = 29;
else
    d = 28;
cout << d << "\n";
```

```
int y = 0, m = 0;
cin >> y >> m;
int d = 0;

switch(m)
{
    case 1: case 3: case 5: case 7:
    case 8: case 10: case 12:
        d = 31;
        break;
    case 4: case 6: case 9: case 11:
        d = 30;
        break;
    case 2:
        if((y % 400 == 0) ||
            (y % 4 == 0 && (y % 100 != 0)))
            d = 29;
        else
            d = 28;
}
cout << d << "\n";
```

Outline

- Preprocessors and namespaces
- Selection
- **Repetition**
 - **while and do-while**
 - **for**
 - Something else

The `while` statement

- In many cases, we want to repeatedly execute a set of codes.
- Last time we studied one **repetition** statement, the **while** statement.
- What do these programs do?

```
int sum = 0;
int i = 1;

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

cout << sum << "\n";
```

```
int exit = 0;
// do something
cout << "Press 1 to exit: ";
cin >> exit;

while(exit != 1)
{
    // do something
    cout << "Press 1 to exit: ";
    cin >> exit;
}
```

Modifying loop counters

- Very often we need to add 1 to or subtract 1 from a **loop counter**.

```
int sum = 0;
int i = 1;

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

cout << sum << "\n";
```

Modifying loop counters

- Using the unary **increment/decrement** operator **++/--** can be more convenient.

```
int sum = 0;
int i = 1;

while(i <= 100)
{
    sum = sum + i;
    i++;
}

cout << sum << "\n";
```

Modifying loop counters

- Binary **self-assigning** operators (e.g., +=) sometimes help.

```
int sum = 0;
int i = 1;

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

cout << sum << "\n";
```


Increment/decrement operators

- In C++, the increment and decrement operators are specific:
 - For modifying **i**, **i++** has the same effect as **i = i + 1**.
 - For modifying **i**, **i--** has the same effect as **i = i - 1**.

```
int i = 10;  
i++; // i becomes 11  
i--; // i becomes 10
```

- They can be applied on all basic data types.
 - But we should only apply them on integers.
- Typically using them is **faster** than using the corresponding addition/subtraction and assignment operation.

Increment/decrement operators

- Both can be put at the **left** or the **right** of the operand.
 - This changes the order of related operations.
 - **i++**: returns the value of **i**, and then increment **i**.
 - **++i**: increments **i**, and then returns the incremented value of **i**.
- What are the values of **a** and **b** in these statements?

```
a = 5; b = a++;
```

```
a = 5; b = ++a;
```

- **i--** and **--i** work in the same way.
- So is **i = i + 1** equivalent to **i++** or **++i**?
- Do not make your program hard to understand!
 - What is **a = b+++++c**?

```
c++;  
a = b + c;  
b++;
```

Self-assigning operations

- In many cases, an assignment operation is **self-assigning**.
 - $a = a + b$, $a = a - 20$, etc.
- For each of the five arithmetic operators $+$, $-$, $*$, $/$, and $\%$, there is a corresponding **self-assignment operator**.
 - $a += b$ means $a = a + b$.
 - $a *= b - 2$ means $a = a * (b - 2)$ (not $a = a * b - 2$).
- Typically $a += b$ is **faster** than $a = a + b$, etc.

The do-while statement

- Recall that we validated a user input with a **while** statement:
- One drawback of this program is that a set of same codes must be written twice.
 - **Inconsistency** may then arise.
- To avoid such a situation, we may use a **do-while** statement.

```
int exit = 0;
// do something
cout << "Press 1 to exit: ";
cin >> exit;

while(exit != 1)
{
    // do something
    cout << "Press 1 to exit: ";
    cin >> exit;
}
```

The do-while statement

- The grammar:
- The revision of the previous program:
- In any case, statements in a **do-while** loop must be executed **at least once**.
- The **semicolon** is needed.
 - Why?

```
do
{
    statements
} while (operation);
```

```
int exit = 0;

do
{
    // do something
    cout << "Press 1 to exit: ";
    cin >> exit;
} while(exit != 1);
```

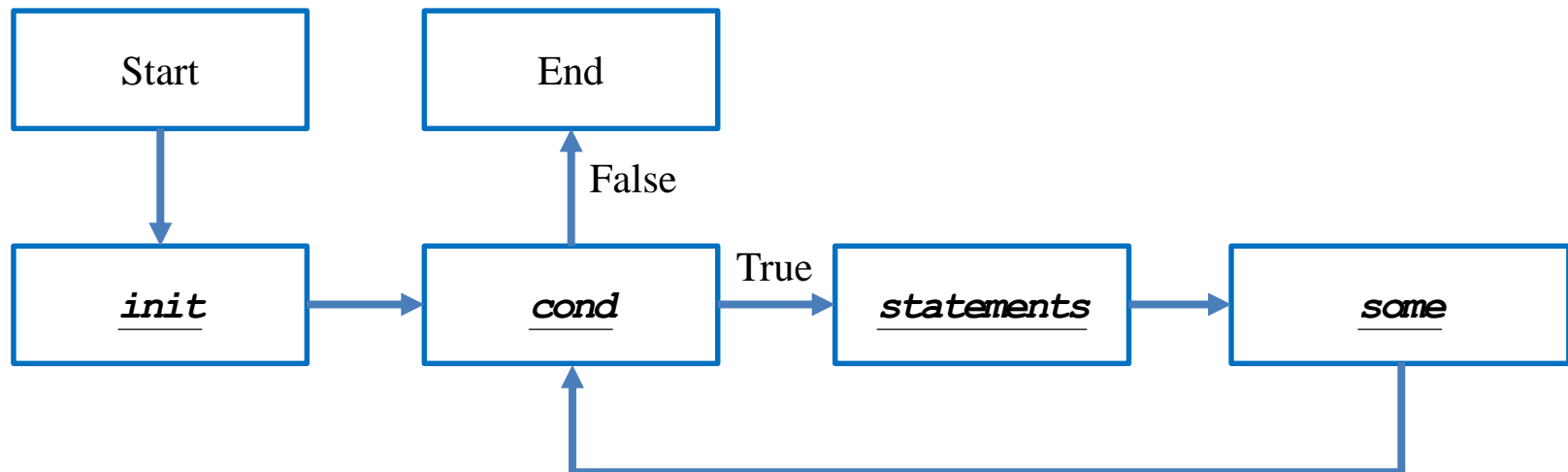
Outline

- Preprocessors and namespaces
- Selection
- **Repetition**
 - **while** and **do-while**
 - **for**
 - Something else

The for statement

- Another way of implementing a loop is to use a **for** statement.
 - The curly brackets can be dropped if there is only one statement.

```
for(init; cond; some)  
{  
    statements  
}
```



The for statement

```
for(init; cond; some)  
{  
    statements  
}
```

- You need those two “;” in the ().
- The typical way of using a for statement is:
 - init: Initialize a **counter variable** here.
 - cond: Set up the condition on the counter variable for the loop to continue.
 - some: Modify (mostly increment or decrement) the counter variable.
 - statements: The things that we really want to do.

for vs. while

- Let's calculate the sum of $1 + 2 + \dots + 100$:
 - We used **while**. How about **for**?
- To use **for**:
 - We declare and initialize the counter variable **i**: **int i = 1**.
 - We check the loop condition: **i <= 1000**.
 - We run the statement: **sum = sum + i**;
 - We then increment the counter: **i++**. **i** becomes **2**.
 - Then we go back to check the condition, and so on, and so on.

```
int sum = 0;
int i = 1;

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

cout << sum << "\n";
```

```
int sum = 0;
for(int i = 1; i <= 100; i++)
    sum = sum + i;
cout << sum;
```

Multi-counter for loops

- Inside one **for** statement:
 - You may initialize **multiple** counters at the same time.
 - You may also check multiple counters at the same time.
 - You may also modify multiple counters at the same time.
- Use “,” to separate operations on multiple counters.
- If any of the conditions is false, the loop will be terminated.
- As an example:

```
for(int i = 0, j = 0; i < 10, j > -5; i++, j--)  
    cout << i << " " << j << "\n";
```

- Try to find alternatives before you use it.

Good programming style

- When you need to execute a loop for **a fixed number of iterations**, use a **for** statement with a counter declared only for the loop.
 - This also applies if you know the maximum number of iterations.
 - This avoids potential conflicts on variable **names**.
 - See “scope of variables” below.
- Use the loop that makes your program the most **readable**.
- Typically only the counter variable enters the () of a **for** statement.
- You may use fractional numbers for a counter, but this is not recommended.
 - Use **integer** only!
- Drop { } only when you know what you are doing.
- Align your { }. Indent your codes properly.

Scope of variables

- A variable has its **scope** (or life cycle).
 - Where it is “alive” and can be accessed.
- For all the variables you have seen so far, they live **only in the block** in which they are declared.

```
int b = 0;
if(b < 10)
{
    int a = 10;
    b++;
}
b = 20; // ok
```

```
for(int i = 0; i < 10; i++)
{
    cout << i << " ";
}
i = 20; // error
```

```
int b = 0;
while(b < 10)
{
    int a = 10;
    b++;
}
a = 20; // error
```

```
int i;
for(i = 0; i < 10; i++)
{
    cout << i << " ";
}
i = 20; // ok
```

Scope of variables

- Two variables declared in the **same level** cannot have the same name.

```
int i = 0;
for(; i < 10; i++)
    cout << i << " ";
// ...
int i = 0; // error!
for(; i < 10; i++)
    cout << i << " ";
```

- This is a good reasons to use **for**: All **loops at the same level** may use the **same name** for loop counters.

- What if we remove the erroneous line?

```
int i = 0;
for(; i < 10; i++)
    cout << i << " ";
// ...
for(; i < 10; i++)
    cout << i << " ";
```

```
for(int i = 0; i < 10; i++)
    cout << i << " ";
// ...
for(int i = 0; i < 10; i++)
    cout << i << " ";
```

Scope of variables

- However, a variable of an existing name is allowed to be declared in an **inner block**.
 - In the inner block, after the same variable name is used to declare a new variable, it “**replaces**” the original one.
 - However, its life ends when the inner block ends.

```
int a = 0;
if(a == 0)
{
    cout << a << "\n"; // ?
    int a = 10;
    cout << a << "\n"; // ?
}
cout << a << "\n"; // ?
```

Outline

- Preprocessors and namespaces
- Selection
- **Repetition**
 - **while** and **do-while**
 - **for**
 - **Something else**

Nested loops

- Like the selection process, **loops** can also be **nested**.
 - Outer loop, inner loop, most inner loop, etc.
- Nested loops are not always necessary, but they can be helpful.
 - Particularly when we need to handle a **multi-dimensional** case.
- E.g., write a program to output some integer points on an (x, y) -plane like this:
(1, 1) (1, 2) (1, 3)
(2, 1) (2, 2) (2, 3)
(3, 1) (3, 2) (3, 3)
- This can still be done with only one level of loop. but using a nested loop is much easier.

```
for(int x = 1; x <= 3; x++)  
{  
    for(int y = 1; y <= 3; y++)  
        cout << "(" << x << ", " << y << ") ";  
    cout << "\n";  
}
```


Infinite loops

- An infinite loop is a loop that does not terminate.

```
int a = 0;
while(a >= 0)
    a++;
```

```
while(true)
    cout << 1;
```

```
for( ; ; )
    cout << 1;
```

- In many cases an infinite loop is a **logical error** made by the programmer.
 - When it happens, check your program.
- When your program does not stop, press <Ctrl + C>.

break and continue

- When we implement a repetition process, sometimes we need to further change the flow of execution of the loop.
- A **break** statement brings us to **exit the loop** immediately.
- When **continue** is executed, statements after it in the loop are **skipped**.
 - The looping condition will be checked immediately.
 - If it is satisfied, the loop starts from the beginning again.
- How to write a program to print out all integers from 1 to 100 except multiples of 10?

```
for(int a = 1; a <= 100; a++)
{
    if(a % 10 != 0)
        cout << a << " ";
}
```

```
for(int a = 1; a <= 100; a++)
{
    if(a % 10 == 0)
        continue;
    cout << a << " ";
}
```

break and continue

- The effect of **break** and **continue** is just on **the current level**.
 - If a **break** is used in an inner loop, the execution jumps to the outer loop.
 - If a **continue** is used in an inner loop, the execution jumps to the condition check of the inner loop.
- What will be printed out at the end of this program?

```
int a = 0, b = 0;
while(a <= 10)
{
    while(b <= 10)
    {
        if(b == 5)
            break;
        cout << a * b << "\n";
        b++;
    }
    a++;
}
cout << a << "\n"; // ?
```

Infinite loops with a break

- We may intentionally create an infinite loop and terminate it with a **break**.
 - E.g., we may wait for an “exit” input and then leave the loop with a **break**.

```
int exit = 0;
// do something
cout << "Press 1 to exit: ";
cin >> exit;

while(exit != 1)
{
    // do something
    cout << "Press 1 to exit: ";
    cin >> exit;
}
```

```
int exit = 0;

while(true)
{
    // do something
    cout << " Press 1 to exit: ";
    cin >> exit;
    if(exit == 1)
        break;
}
```

break and continue

- Using **break** gives a loop **multiple exits**.
 - It becomes harder to track the flow of a program.
 - It becomes harder to know the state after a loop.
- Using **continue** highlights the need of **getting to the next iteration**.
 - Having too many continue still gets people confused.
- Be careful **not to hurt the readability** of a program too much.