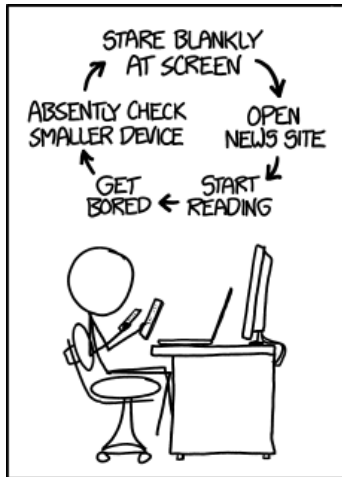


CS319: Scientific Computing**I/O, flow, loops, and functions**

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Week 3: 29 and 31 January,
2026Source: [xkcd \(1411\)](#)Slides and examples: <https://www.niallmadden.ie/2526-CS319>

0. Inputs for this weeks classes:

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Slides and examples:
niallmadden.ie/2526-CS319



1. Preview of Lab 1

1. Labs start this week.
2. Attend (at least) one hour Thurs 9-10 or Friday 12-1 in AdB-G021.
3. Lab 1 is concerned with program structure, conditionals, and loops. And a little about numbers in C++
4. Submit your C++ file as it is on Friday. This is just to test that you upload the correct file, and to verify participation. So long as you upload a C++ file, you'll get the mark.

2. Recall from Week 2

In Week 2 we studied how numbers are represented in C++.

We learned that all are represented in binary, and that, for example,

- ▶ An **int** is a whole number, stored in 32 bytes. It is in the range $-2,147,483,648$ to $2,147,483,647$.
- ▶ A **float** is a number with a fractional part, and is also stored in 32 bits.

A positive **float** is in the range 1.1755×10^{-38} to 3.4028×10^{38} .

Its **machine epsilon** is $2^{-23} \approx 1.192 \times 10^{-7}$.

- ▶ A **double** is also number with a fractional part, but is stored in 64 bits.

A positive **double** is in the range 2.2251×10^{-308} to 31.7977×10^{308} .

Its **machine epsilon** is $2^{-53} \approx 1.1102 \times 10^{-16}$.

3. Basic Output

Last week we had this example: *To output a line of text in C++:*

```
#include <iostream>
```

```
int main() {
```

```
    std::cout << "Howya World.\n";
```

```
    return(0);
```

```
}
```

'\n' ~> new line.

*Better: std::cout << "x=" << x ;
std::cout << "x=" << x << "y=" << y;*

- ▶ the identifier **cout** is the name of the **Standard Output Stream** – usually the terminal window. In the programme above, it is prefixed by **std::** because it belongs to the *standard namespace*...
- ▶ The operator **<<** is the **put to** operator and sends the text to the *Standard Output Stream*.
- ▶ As we will see **<<** can be used on several times on one lines.
E.g.

```
std::cout << "Howya World." << "\n";
```

As well as passing variable names and string literals to the output stream, we can also pass **manipulators** to change how the output is displayed.

For example, we can use `std::endl` to print a new line at the end of some output.

In the following example, we'll display some Fibonacci numbers. These are defined by the recurrence: $f_0 = 1$, $f_1 = 1$, and, for $i > 1$, $f_i = f_{i-1} + f_{i-2}$.

We'll use the `for` construct, which will be explained later in this class.

01Manipulators.cpp

```
4 #include <iostream>
  #include <string>
6 #include <iomanip>
  int main()
8 {
    int i, fib[16];
10    fib[0]=1; fib[1]=1;

12    std::cout << "Without setw manipulator" << std::endl;
    for (i=0; i<=12; i++)
14    {
        if( i >= 2)
16        fib[i] = fib[i-1] + fib[i-2];
        std::cout << "The " << i << "th " <<
18        "Fibonacci Number is " << fib[i] << std::endl;
    }
```

$$f_0 = 1$$

$$f_1 = 1$$

$$f_2 = f_0 + f_1 = 2$$

$$f_3 = f_2 + f_1 = 3$$

$$f_4 = f_3 + f_2 = 5$$


$$f_5 = f_4 + f_3 = 8$$


- `std::setw(n)` will the width of a field to *n*. Useful for tabulating data.

01Manipulators.cpp

```
22  std::cout << "With the setw  manipulator" << std::endl;
    for (i=0; i<=12; i++)
    {
24      if( i >= 2)
          fib[i] = fib[i-1] + fib[i-2];
26      std::cout
          << "The " << std::setw(2) << i << "th "
28          << "Fibonacci Number is "
          << std::setw(3) << fib[i] << std::endl;
30    }
```


Other useful manipulators:

- ▶ `setfill`  the character to use when filling.
- ▶ `setprecision`
- ▶ `fixed` and `scientific`
- ▶ `dec`, `hex`, `oct`



Number of decimal places to represent. etc

5. Input

In C++, the object `cin` is used to take input from the standard input stream (usually, this is the keyboard). It is a name for the **C**onsole **I**Nput.

In conjunction with the operator `>>` (called the **get from** or **extraction** operator), it assigns data from input stream to the named variable.

(In fact, `cin` is an **object**, with more sophisticated uses/methods than will be shown here).

5. Input

02Input.cpp

```
4 #include <iostream>
#include <iomanip> // needed for setprecision
6 int main()
{
8     const double StirlingToEuro=1.19099; // Correct 28/01/2026
    double Stirling;
10     std::cout << "Input amount in Stirling: ";
    std::cin >> Stirling;
12     std::cout << "That is worth "
                << Stirling*StirlingToEuro << " Euros\n";
14     std::cout << "That is worth " << std::fixed
                << std::setprecision(2) << "\u20AC"
                << Stirling*StirlingToEuro << std::endl;
16     return(0);
18 }
```

6. Flow of control – if-blocks

`if` statements are used to conditionally execute part of your code.

Structure (i):

```
if ( exprn )  
{  
    statements to execute if exprn evaluates as  
        non-zero  
}  
else  
{  
    statements if exprn evaluates as 0  
}
```

6. Flow of control – if-blocks

Note: { and } are optional if the block contains a single line.

Example:

```
if (x == 1)
    x++;
```

is the same as

```
if (x == 1)
{
    x++;
}
```

Python:

```
if (x == 1):
    x += 1
```

Catch

```
if (x > y)
    x++j y=xj
```

is not the same as

```
if (x > y)
{
    x++j y=xj
}
```

6. Flow of control – if-blocks

The argument to `if()` is a **logical expression**.

Example

- ▶ `x == 8`
- ▶ `m == '5'`
- ▶ `y <= 1`
- ▶ `y != x`
- ▶ `y > 0`

More complicated examples can be constructed using

- ▶ **AND** `&&`
and
- ▶ **OR** `||`.

6. Flow of control – if-blocks

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03EvenOdd.cpp

```
12 int main(void)
13 {
14     int Number;
15
16     std::cout << "Please enter an integer: ";
17     std::cin >> Number;
18
19     if ( (Number%2) == 0)
20         std::cout << "That is an even number." << std::endl;
21     else
22         std::cout << "That number is odd." << std::endl;
23     return(0);
24 }
```

$a \% b$ is the remainder on dividing
a by b.

6. Flow of control – if-blocks

More complicated examples are possible:

Structure (ii):

```
if ( exp1 )  
{  
    statements to execute if exp1 is "true"  
}  
else if (exp2)  
{  
    statements run if exp1 is "false" but exp2 is "true"  
}  
else  
{  
    "catch all" statements if neither exp1 or exp2 true.  
}
```

} can
have
multiple
"if
else".

6. Flow of control – if-blocks

04Grades.cpp

```
12  int NumberGrade;
13  char LetterGrade;

14  std::cout << "Please enter the grade (percentage): ";
15  std::cin >> NumberGrade;
16  if ( NumberGrade >= 70 )
17      LetterGrade = 'A';
18  else if ( NumberGrade >= 60 )    60 ≤ B ≤ 69
19      LetterGrade = 'B';
20  else if ( NumberGrade >= 50 )    50 ≤ C ≤ 59
21      LetterGrade = 'C';
22  else if ( NumberGrade >= 40 )
23      LetterGrade = 'D';
24  else
25      LetterGrade = 'E';

26
27  std::cout << "A score of " << NumberGrade
28              << "% cooresponds to a "
29              << LetterGrade << "." << std::endl;
```

6. Flow of control – if-blocks

The other main flow-of-control structures are $(a==b)? a=c: a=d;$

- ▶ the ternary the `?:` operator, which can be useful for formatting output, in particular, and
- ▶ `switch ... case` structures.

*if
a != b*

Exercise 2.1

Find out how the `?:` operator works, and write a program that uses it.

Hint: See Example 07IsComposite.cpp

Exercise 2.2

Find out how `switch... case` construct works, and write a program that uses it.

Hint: see https://runestone.academy/ns/books/published/cpp4python/Control_Structures/conditionals.html

We meet a `for`-loop briefly in the Fibonacci example. The most commonly used loop structure is `for`

```
for (initial value; test condition; step)
{
    // code to execute inside loop
}
```

or
increment.

Example: 05CountDown.cpp

```
10 int main(void)
11 {
12     int i;
13     for (i=10; i>=1; i--)
14         std::cout << i << "... ";
15     std::cout << "Zero!\n";
16     return(0);
17 }
```

step

$i--$;
is the same
as $i = i - 1$;
which is the same
as $i = 1$;

1. The syntax of `for` is a little unusual, particularly the use of semicolons to separate the “arguments”.
2. All three arguments are optional, and can be left blank.

Example:

E.g,

```
for (i=0; i<4; i++)  
    { /* do stuff */ }
```

is the same as

```
i=0;  
for ( ; i<4 ; i++)  
{ /* do stuff */ }
```

3. But it is not good practice to omit any of them, and very bad practice to leave out the middle one (test condition).

4. It is very common to define the increment variable within the for statement, in which case it is “local” to the loop. Example:

```
int i;  
for(i=0; i<10; i++)  
{  
    --  
}
```

for (int i=0; i<10; i++)
{
 --
}

5. As usual, if the body of the loop has only one line, then the “curly braces”, { and }, are optional.
6. There is no semicolon at the end of the for line.

```
for (int i=0; i<10; i++);  
/* do stuff */
```

} wrong!

Finished here, but do read through the next slide before the lab

The other two common forms of loop in C++ are

- ▶ `while` loops
- ▶ `do ... while` loops

Exercise 2.3

Find out how to write a `while` and `do ... while` loops. For example, see

https://runestone.academy/ns/books/published/cpp4python/Control_Structures/while_loop.html

Rewrite the **count down** example above using a

1. `while` loop.
2. `do ... while` loop.