

122COM: Introduction to C++

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Overview

1 Languages

2 C++

■ Variables

3 Syntax

■ Conditionals

■ Arrays

■ Loops

■ while

■ for

■ Compiling

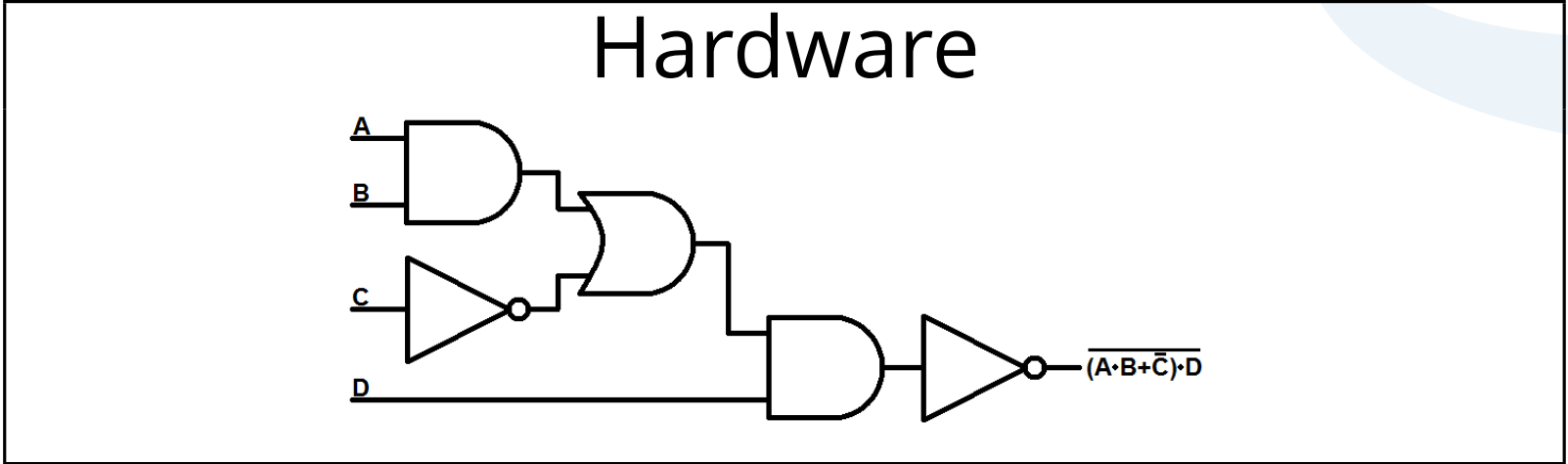
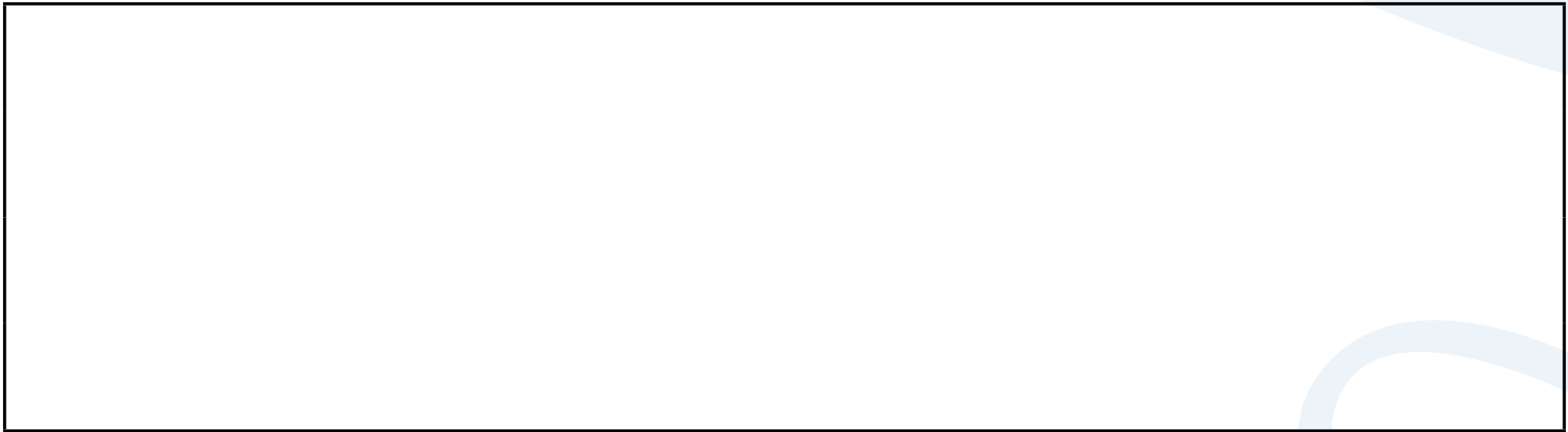
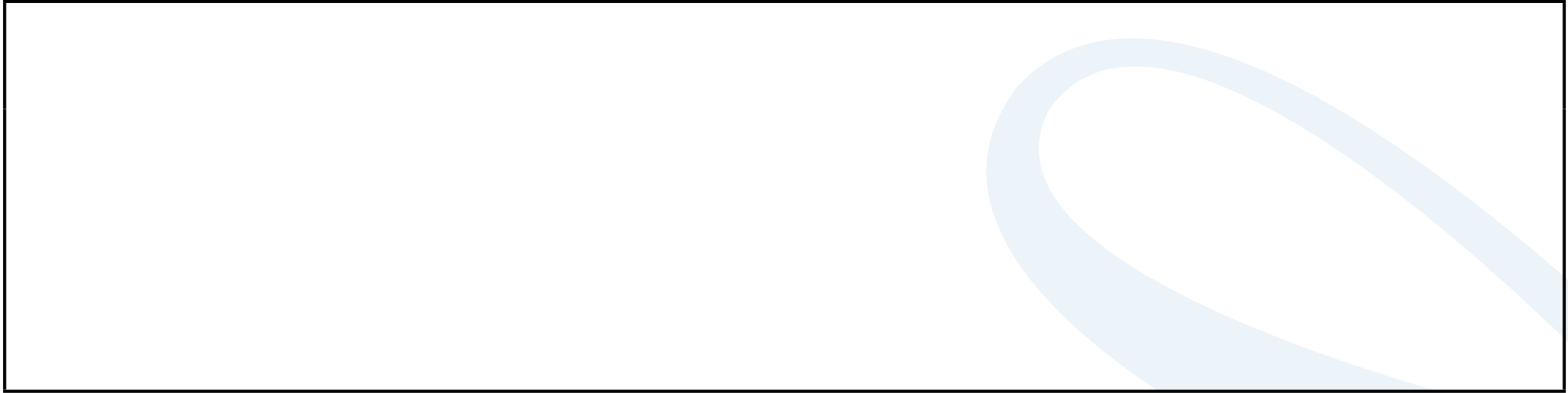
■ Debugging

4 Recap

Highs and lows

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- Programming languages split into levels.
- Low level languages are machine code, assembly language.
- High level languages are Python, C++, Java etc.



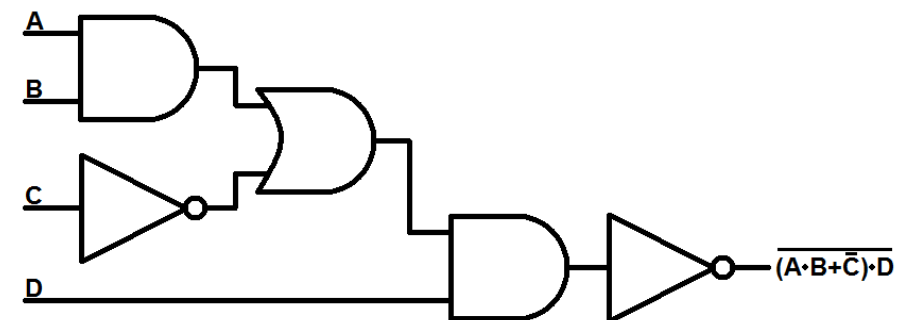


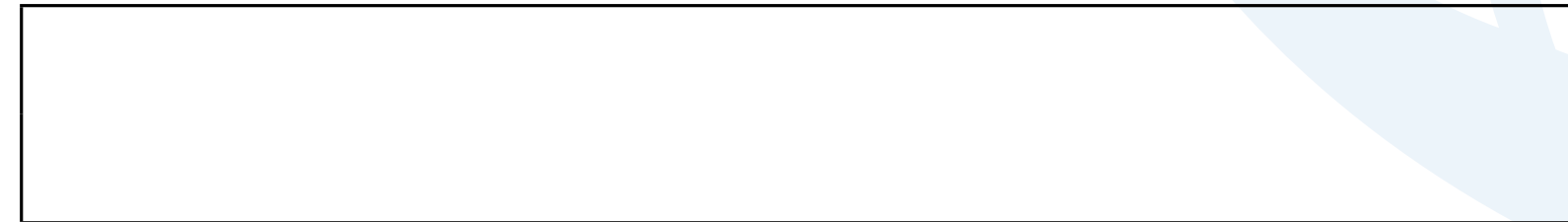
Machine code

```
01010011 01100101 01110010 01101001
01101111 01110101 01110011 01101100 01111001
00111111 01111001 00111111
```



Hardware

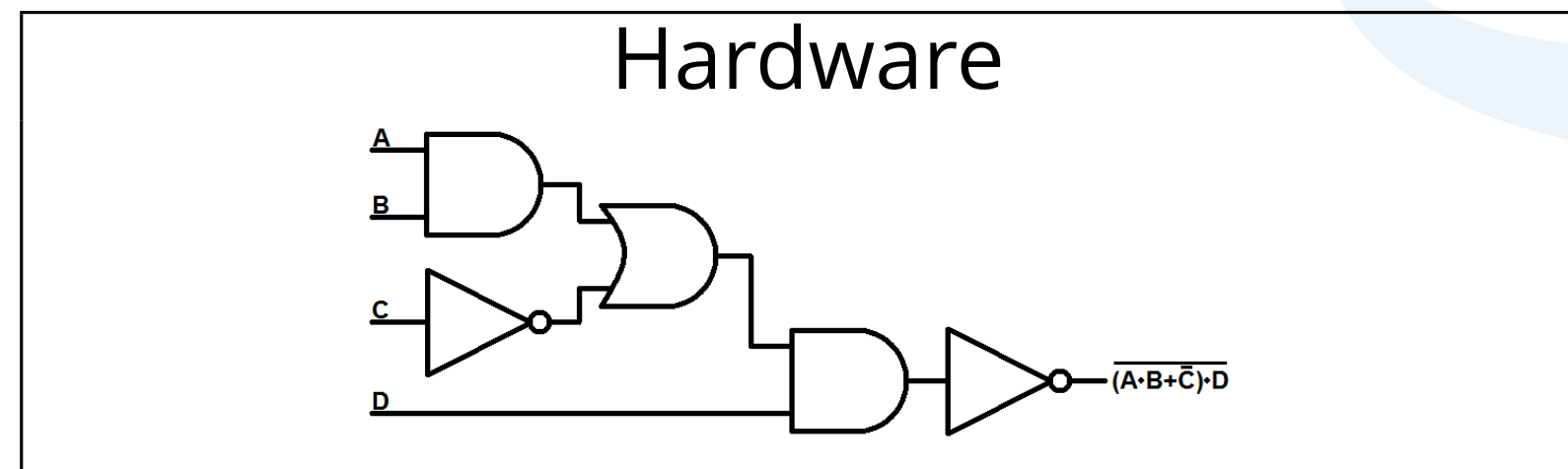




Assembly
GOTO 0x42
INCF 0x68 0x01
SLEEP



Machine code
01010011 01100101 01110010 01101001
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High level languages

`i+=1`



Assembly

`GOTO 0x42`

`INCF 0x68 0x01`

`SLEEP`

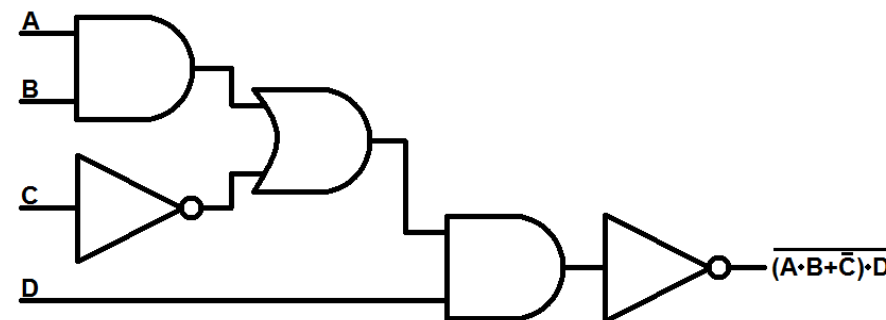


Machine code

01010011 01100101 01110010 01101001
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Hardware





↑↑

High level	Python, Ruby Java C C++ Forth, Basic	3 rd generation
Low level	Assembly	2 nd generation
	Machine code	1 st generation
	Hardware	

↓↓



Machine code

Languages

C++

Variables

Syntax

Conditionals

Arrays

Loops

while

for

Compiling

Debugging

Recap

Machine code

- 1st generation.
- Really hard to understand.
- Really hard to write.
- The actual instructions to the hardware.

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Assembly

- 2nd generation.
- Hard for humans to understand.
- Hard for humans to write.
- 1-to-1 correspondence with what is run.

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- Portable.

High level

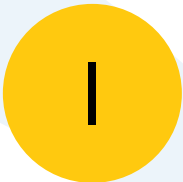
Python, C, C++, Java, PHP, Perl etc.

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- Favour programmer, not machine.
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- Portable.
 - Different machine == different compiler.
 - Same C/Python/C++/Java code.

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- Portable.
 - Different machine == different compiler.
 - Same C/Python/C++/Java code.



So far you have used Python.

So far you have used Python.
Now going to learn C++.

History of C++

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- Created somewhere in 1979-1983.

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- Going to be learning C++11 (approved 2011).

So far you have used Python.
Now going to learn C++.

- Created somewhere in 1979-1983.
- Based on C (created 1972).
 - Going to be learning C++11 (approved 2011).
- C++14 has been approved (2014).
 - No support yet.
- 99.9% backwards compatible.
 - All the way to C.
- Supports the same paradigms as Python.
 - Object oriented, functional, declarative etc.

- All students are expected to learn some C++.
- In future weeks we will be looking at generic programming concepts.
 - Sorting.
 - Searching.
 - Data structures.
- Those weeks will be taught in Python and C++.
 - Everyone else will have some mandatory C++ tasks.
 - BIT & MC students can choose Python or C++ most tasks.
 - Will be specified at the time.
- BIT & MC will not be examined on C++ code.
 - May be examined on language differences.
 - High/low languages.
 - Compiling.
 - Static/dynamic typing.
 - Stack/heap memory.

Most significant difference...

- C++ is statically typed.
 - Python is dynamically typed.

- In Python variables keep track of values AND type.

```
var = 42           # type(var) = <type 'int'>
var = 'foo'        # <type 'str'>
var = 0.123        # <type 'float'>
```

- In C++ variables have one type forever.
 - Have to specify type when creating.

```
int    var1 = 42;
string var2 = "foo";
float  var3 = 0.123;
```

Data types

C

In C++ have to specify a variable's type.

- So what types are available?
- Thousands (at least).
 - You can create your own.
- Few standard ones.
- Most basic data types are called primitive types.

Primitive types

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- Knowing what the different variables are.
- Knowing all the primitives and the variations.
- Knowing ranges/sizes.

Type	Bytes	Values
bool	1	true/false
char	1	'a', 'Z', '6', '+'
int	4	-2147483647 → 2147483647
unsigned int	4	0 → 4294967295
float	4	1.234, -0.0001
double	8	1.23456789, -0.0000000001
void		

Sizes are correct for a 32bit machine.

Moving from Python to C++.

- Not as bad/scary as it seems.
- Same basic structure.
- Slightly different syntax.

Python.

```
print('Hello World!')
```

Hello World!

C

Hello World!

C

Python.

```
print('Hello World!')
```

```
import sys

def main():
    print('Hello World!')

if __name__ == '__main__':
    sys.exit(main())
```

Python.

```
print('Hello World!')
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import sys
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def main():  
    print('Hello World!')
```

```
if __name__ == '__main__':  
    sys.exit(main())
```

Hello World!

C

C++.

```
#include <iostream>  
using namespace std;  
  
int main()  
{  
    cout << "Hello World!" << endl;  
  
    return 0;  
}
```

Hello World!

C

Python.

```
print('Hello World!')
```

```
import sys
```

```
def main():
```

```
    print('Hello World!')
```

```
if __name__ == '__main__':  
    sys.exit(main())
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C++.

```
#include <iostream>
```

```
using namespace std;
```

```
int main()
```

```
{
```

```
    cout << "Hello World!" << endl;
```

```
    return 0;
```

```
}
```

- All programs in C++ **MUST** have exactly one `main()` function.
- C++ uses `{` and `}` instead of indentation.
 - You should still have indentation in C++ but is aesthetic only.
- Semi-colons at the end of lines.

if statements

C

Same rules as Python.

- Slightly different syntax.
- and is now &&.
- or is now | |.
- == is still ==.

if statements

C

Same rules as Python.

- Slightly different syntax.
- and is now &&.
- or is now ||.
- == is still ==.

```
a = 1
b = 2

if a == b and b > 0:
    print('Hello World')
```

Same rules as Python.

- Slightly different syntax.
- and is now &&.
- or is now | |.
- == is still ==.

```
a = 1
b = 2

if a == b and b > 0:
    print('Hello World')
```

if statements

C

```
int a = 1;
int b = 2;

if( a == b && b > 0 )
{
    cout << "Hello World!" << endl;
}
```

Similar to Python lists.

- Can't be resized.

```
sequence = [1, 2, 42, 69, 8]
sum = 0

for i in range(len(sequence)):
    sum += sequence[i]
```

```
int sequence[5] = {1, 2, 42, 69, 8};
int sum = 0;

for( int i=0; i<5; i+=1 )
{
    sum += sequence[i];
}
```

Three ways to create a C array.

1 Just supply size

```
int    arrayOfInt [3] ;  
char   arrayOfChars [5] ;  
float  arrayOfFloats [2] ;
```

2 Supply size and initialisation list

```
int    arrayOfInt [3]      = { 42, 69, 12 } ;  
char   arrayOfChars [5]   = { 'A', 'z', '9' } ;  
float  arrayOfFloats [2]  = { 1.23, 0.001, 8.1 } ;
```

3 Just initialisation list (will figure out the size)

```
int    arrayOfInt []      = { 42, 69, 12 } ;  
char   arrayOfChars []   = { 'A', 'z', '9' } ;  
float  arrayOfFloats []  = { 1.23, 0.001, 8.1 } ;
```


So far looked at the old style arrays.

- Carried forward from C.
- Still used today.
- C++03 introduced an alternative.
 - STL arrays.

New and improved!

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So far looked at the old style arrays.

- Carried forward from C.
- Still used today.
- C++03 introduced an alternative.
 - STL arrays.

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

int main()
{
    int oldArray[5] = {1,2,3,4,5};
    array<int,5> newArray = {1,2,3,4,5};

    cout << oldArray[0] << " " << newArray[0] << endl;

    return 0;
}
```

There's two of them?

I

Two types of arrays.

- Old style arrays are still very common.
 - Legacy.
 - Want you to start off using the new ones.
- What was wrong with the old ones?
- New arrays are safer.
 - Avoid overflows.
- Easier to use.
 - Sorting, searching, reversing, iterating etc.
- Are backwards compatible with old code.

Problem, C++ arrays have a set size.

- Saw we had to provide a size when declaring arrays.

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C++ does have 'arrays' that can be resized.

- Called vectors.
- Uses arrays inside.

Problem, C++ arrays have a set size.

- Saw we had to provide a size when declaring arrays.

C++ does have 'arrays' that can be resized.

- Called vectors.
- Uses arrays inside.

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

int main()
{
    array<int,5> myArray = {1,2,3,4,5};
    vector<int> myVector = {1,2,3,4};

    myVector.push_back(5);

    cout << myArray[0] << endl;
    cout << myVector[0] << endl;
}
```

C++ vectors are the closest thing to Python lists.

- If you are moving to C++ from Python easier to use vectors?
- `append()` → `push_back()` and `emplace_back()`
- `pop()` → `pop_back()`
- slicing → `resize()`

Same rules as Python.

- Slightly different syntax.
- Brackets ().
- Braces {}.
- Semicolons ;.

```
counter = 0
while counter < 10:
    print('Hello World!')
    counter += 1
```

```
int counter = 0;
while( counter < 10 )
{
    cout << "Hello World!" << endl;
    counter += 1;
}
```

while loops

C

C++ has two kinds of for loops.

- One type similar to Python for loops.
 - Actually a range-based loop.
 - Will be covered later.
- One type similar to a while loop.

The original C++ for loop.

```
for( int counter=0; counter<10; counter+=1 )  
{  
    cout << "Hello World!" << endl;  
}
```

for loops

C

The original C++ for loop.

- Seems very different to the python loop.

```
for counter in range(10):  
    print('Hello World!')
```

```
for( int counter=0; counter<10; counter+=1 )  
{  
    cout << "Hello World!" << endl;  
}
```

The original C++ for loop.

- Seems very different to the python loop.
- Lots of commonalities.

```
for counter in range(10):  
    print('Hello World!')
```

```
for counter in range(0,10,1):  
    print('Hello World!')
```

```
for( int counter=0; counter<10; counter+=1 )  
{  
    cout << "Hello World!" << endl;  
}
```

The original C++ for loop.

- Seems very different to the python loop.
- Lots of commonalities.
- Also to while loops.

```
for counter in range(10):  
    print('Hello World!')
```

```
for counter in range(0,10,1):  
    print('Hello World!')
```

```
for( int counter=0; counter<10; counter+=1 )  
{  
    cout << "Hello World!" << endl;  
}
```

```
int counter = 0;  
while( counter < 10 )  
{  
    cout << "Hello World!" << endl;  
    counter += 1;  
}
```

The new C++11 ranged for loop, for iterating over a sequence.

- Less powerful than the old style.
- Easier.
- while > for > ranged for

Ranged for loops

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```
sequence = [1,2,3,4,5]
for i in sequence:
    print( i )
```

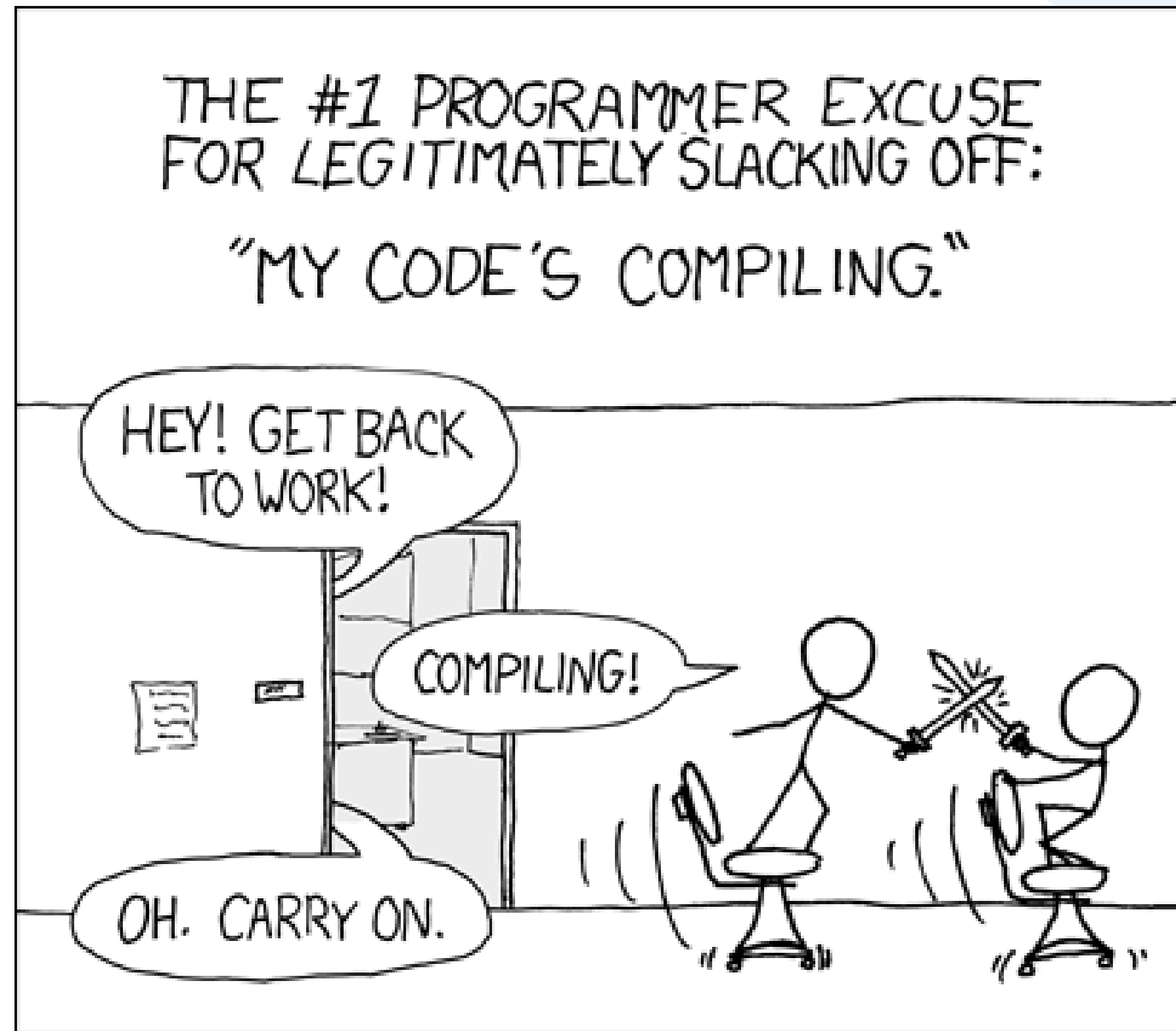
```
int main()
{
    array<int,5> sequence =
        { 1, 2, 3, 4, 5 };
    for( int i : sequence )
    {
        cout << i << endl;
    }

    return 0;
}
```

C++ code has to be compiled before it is run.

- So does Python it just happens automatically.
- Compiler converts C++ code into machine code.
- Many IDEs handle compiling for you.
 - Visual Studio, Eclipse etc.

Compiling



gcc & g++

C

GNU C Compiler (created 1987).

- Linux, Mac and Windows.

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How to compile using g++.

- Demo
- `g++ -std=c++11 hello.cpp -o hello`
 - `g++` - the compiler program.
 - `-std=c++11` - we want to use the C++11 standard of C++.
 - `hello.cpp` - the file we want to compile.
 - `-o hello` - the name of the executable to create.

What if your code is wrong?

- Same as Python.
 - Syntax errors.
 - Runtime errors.
 - Logic errors.

What if your code is wrong?

- Same as Python.
 - Syntax errors.
 - Runtime errors.
 - Logic errors.
- Spot the errors.

Debugging

C

```
int main()
{
    cout << "Hi" << endl;

    for( int i=0; i>10; j+=1 )
    {
        cut << "Hello World!" << endl
    }

    return 0;
}
```

Quiz

Recap

- C++ is a high level language.
 - 3rd generation.
- Compiled.
- Statically typed.
- Arrays cannot be resized.
 - Use new STL arrays.

The End