

# 122COM: Programming languages

David Croft

Coventry University

david.croft@coventry.ac.uk

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# Overview

## 1 Languages

## 2 C++

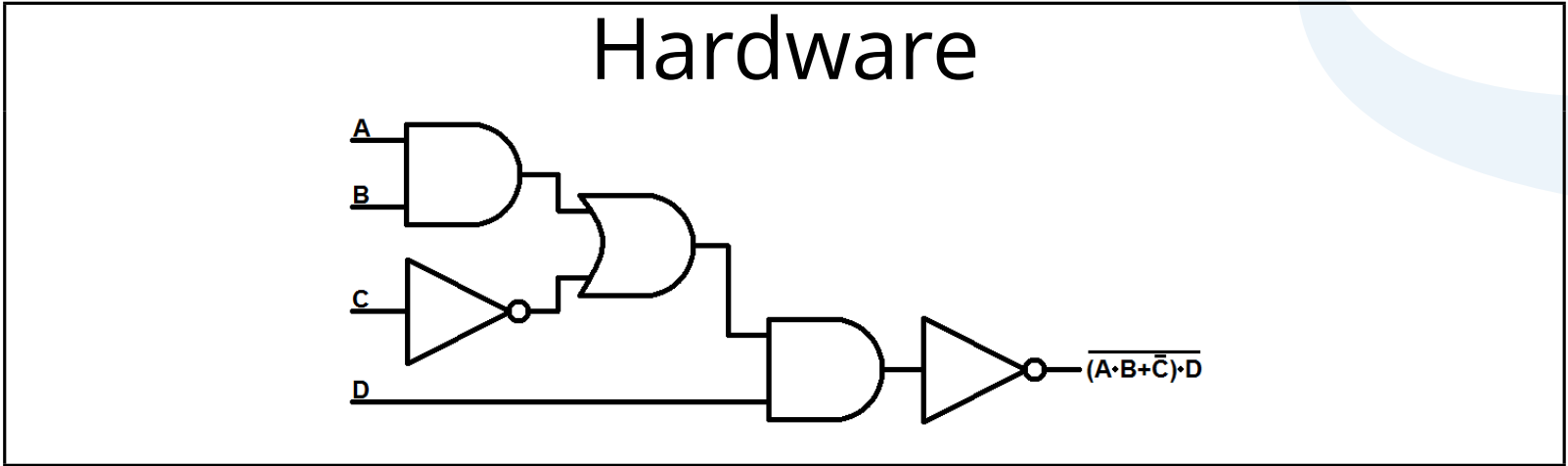
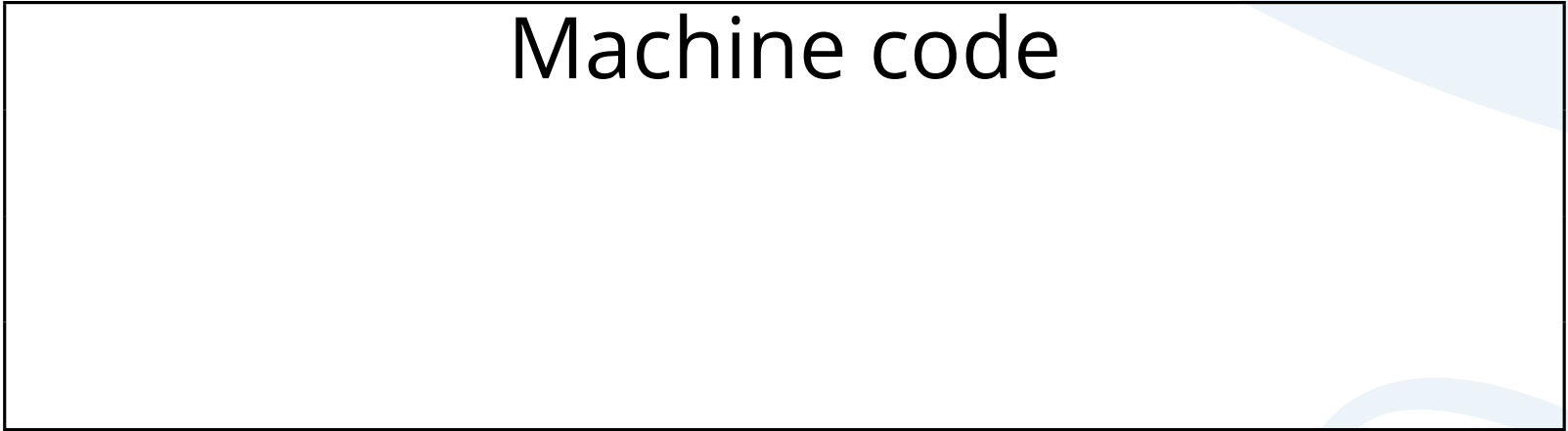
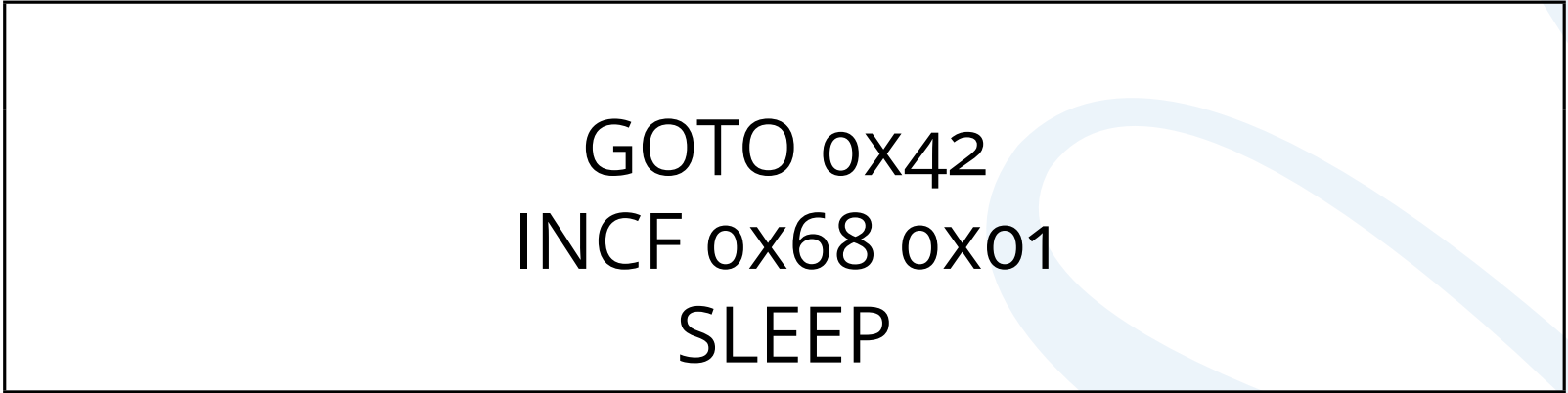
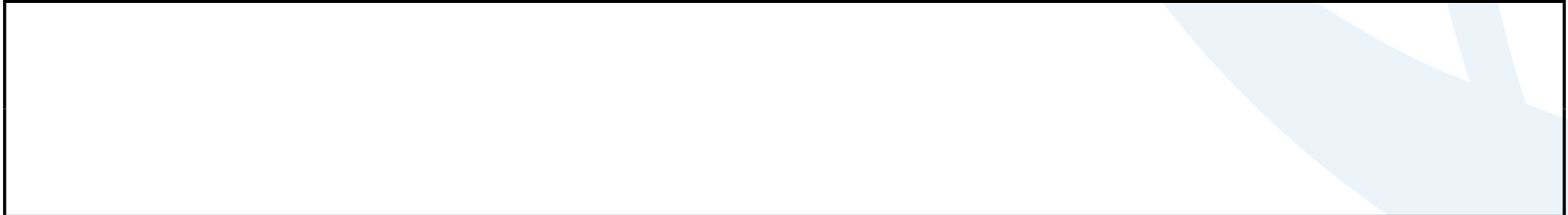
## 3 Syntax

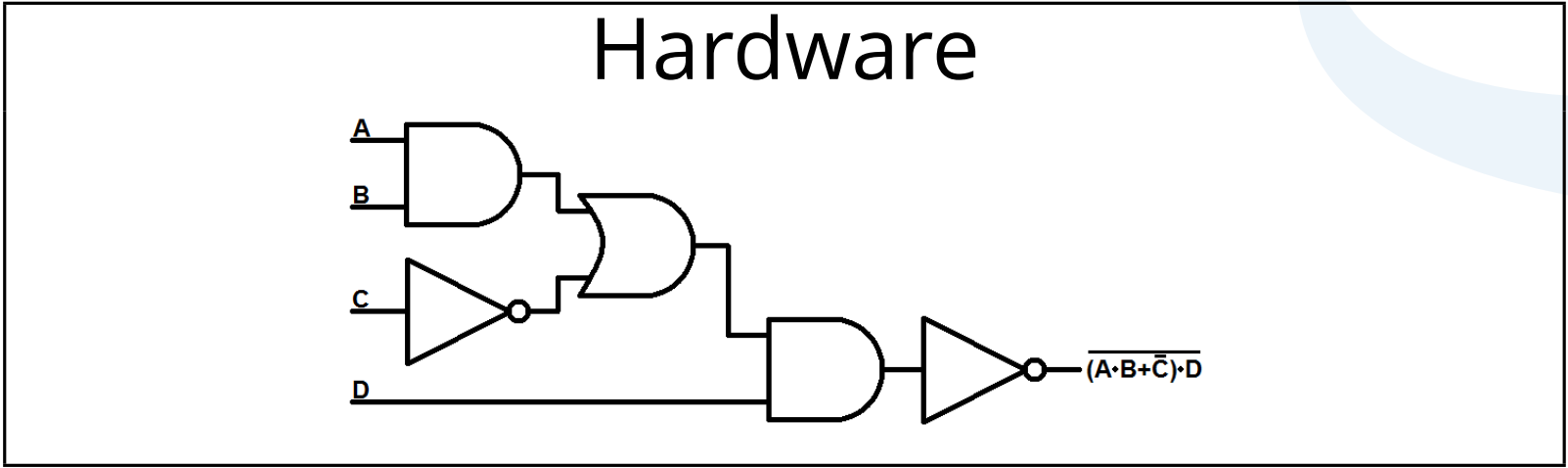
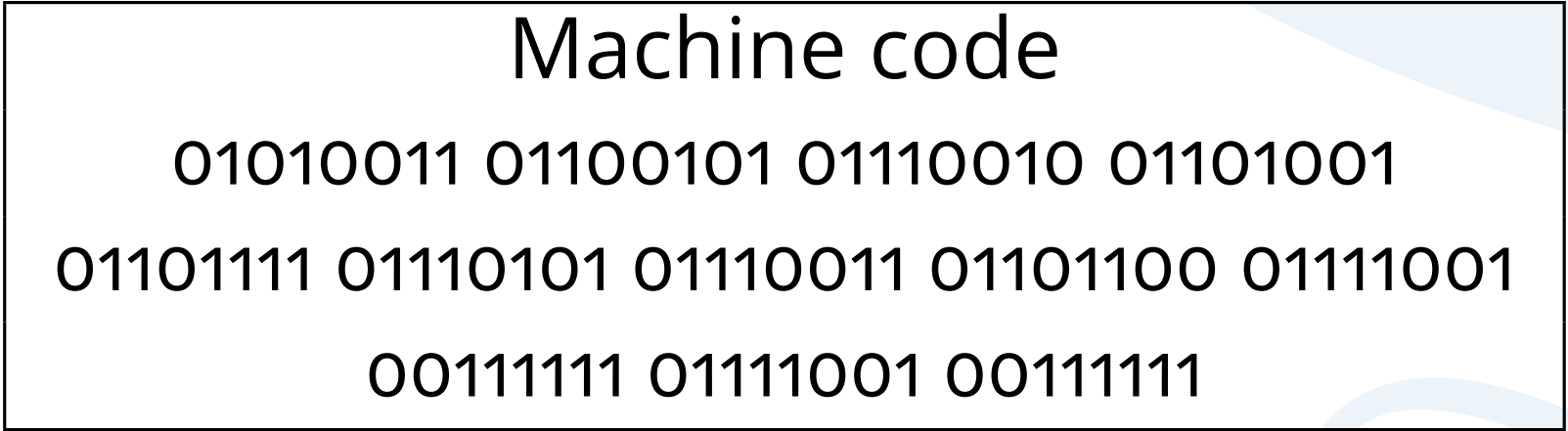
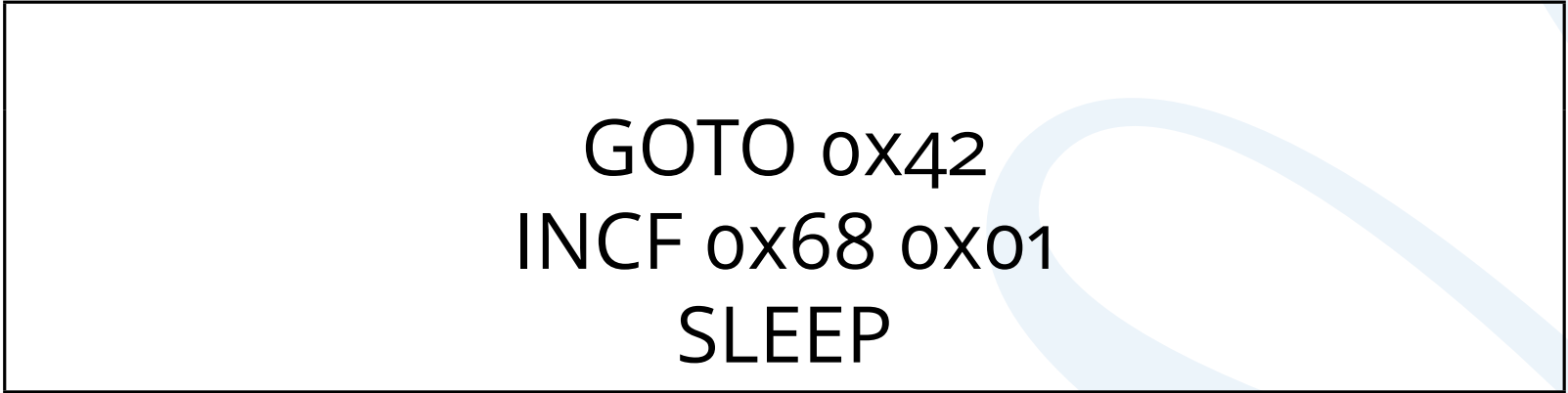
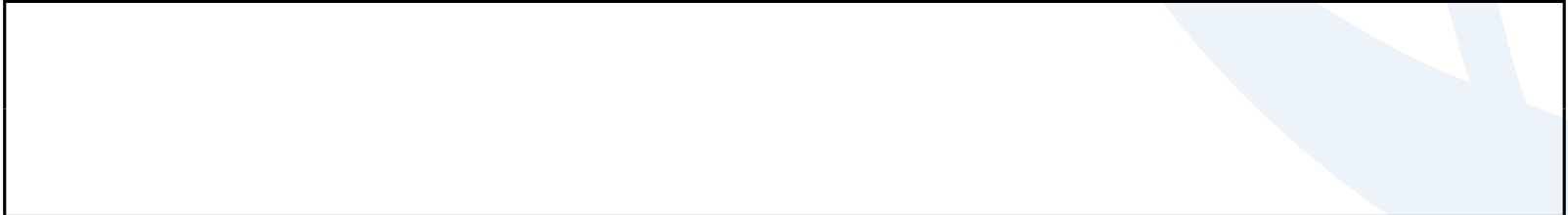
- Conditionals
- Arrays
- Loops
  - while
  - for
- Compiling

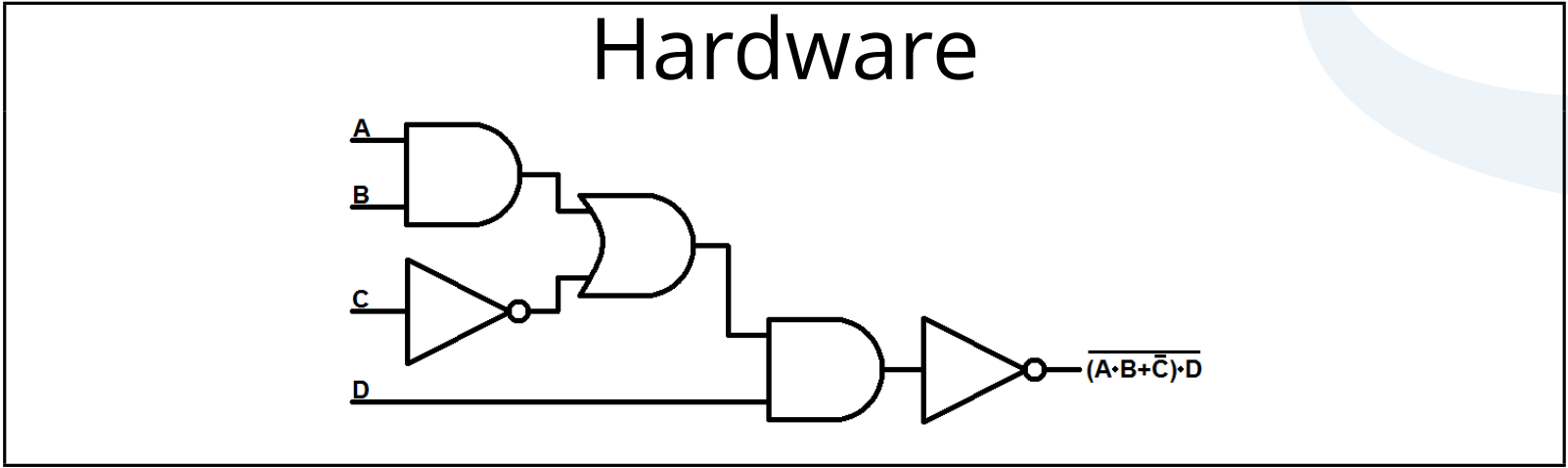
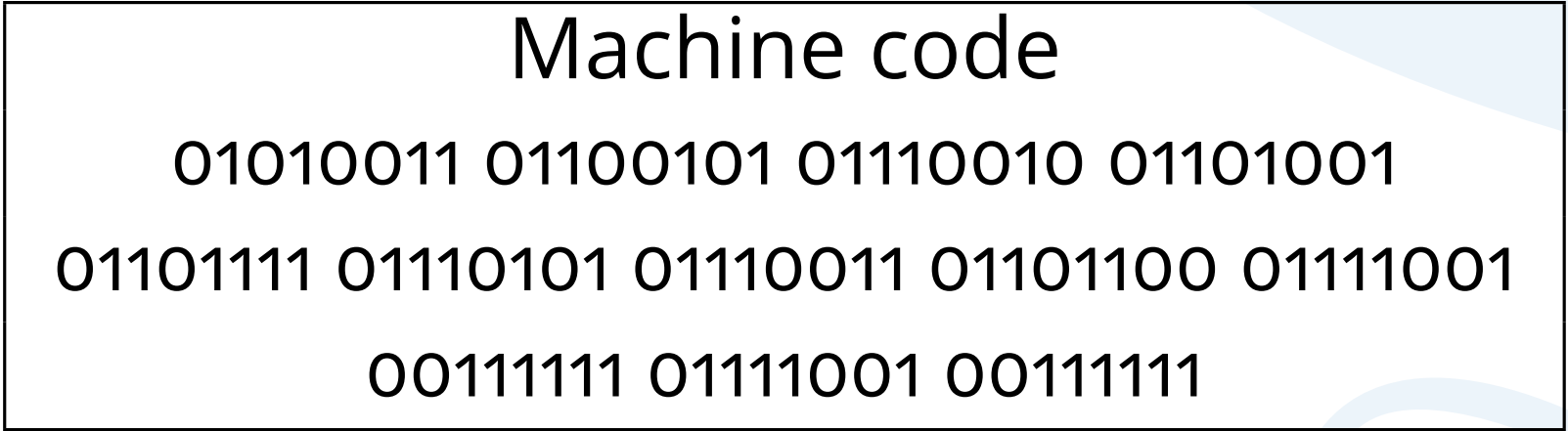
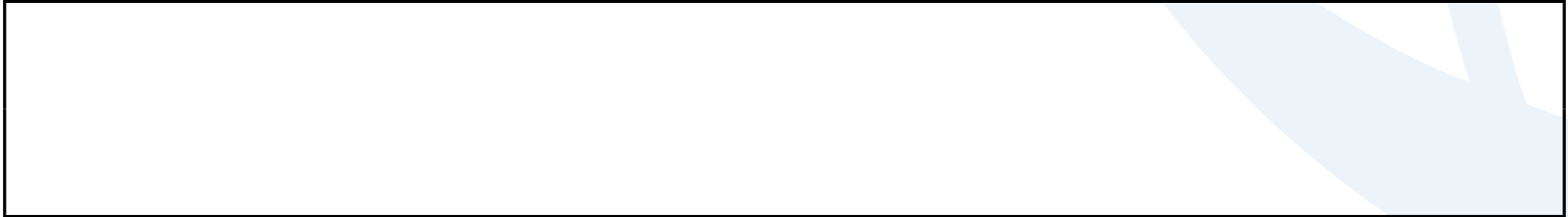
## 4 Recap

# Highs and lows

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







High level languages

`i+=1`



Assembly

`GOTO 0x42`

`INCF 0x68 0x01`

`SLEEP`

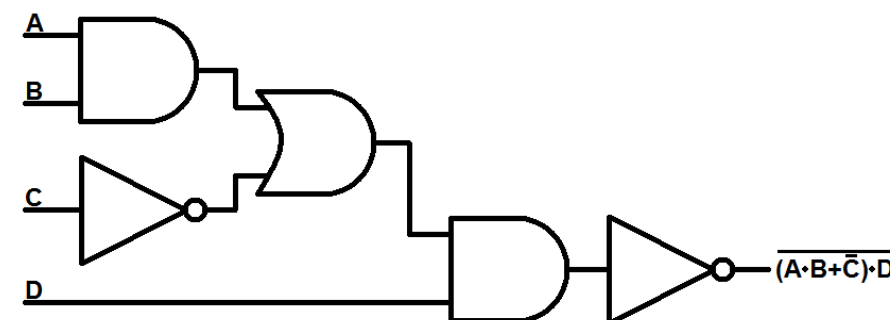


Machine code

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



Hardware



↑

↓

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



# Machine code

Languages

C++

Syntax

Conditionals

Arrays

Loops

while

for

Compiling

Recap

# Low level

## Machine code

- 1<sup>st</sup> generation.
- Really hard to understand.
- Really hard to write.
- The actual instructions to the hardware.

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- 1-to-1 correspondence with what is run.

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

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# History of C++

So far you have used Python.

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Now going to learn C++.

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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.

# Expectations

- 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 students can choose Python or C++ most tasks.
  - Will be specified at the time.
- BIT will not be examined on C++ code.
  - May be examined on language differences.
  - High/low languages.
  - Compiling.
  - Static/dynamic typing.
  - Stack/heap memory.

# About C++

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

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

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.

# Syntax

Moving from Python to C++.

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

# Hello World!

## Python.

```
import sys

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

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

## C++.

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

int main()
{
    cout << "Hello World!" << endl;

    return 0;
}
```



# if statements

Same rules as Python.

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

# if statements

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- Slightly different syntax.
- and is now &&.
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```
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

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

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

# Arrays

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];
}
```

# Arrays II

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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- 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?

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.



# Vectors

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

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

- Called vectors.
- Uses arrays inside.

# Vectors

```
#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;
}
```

# Vectors II

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()`

# while loops

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;
}
```

# for loops

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.

# for loops

The original C++ for loop.

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

# for loops

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;  
}
```



# for loops

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;  
}
```

# for loops

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

```
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;
    }

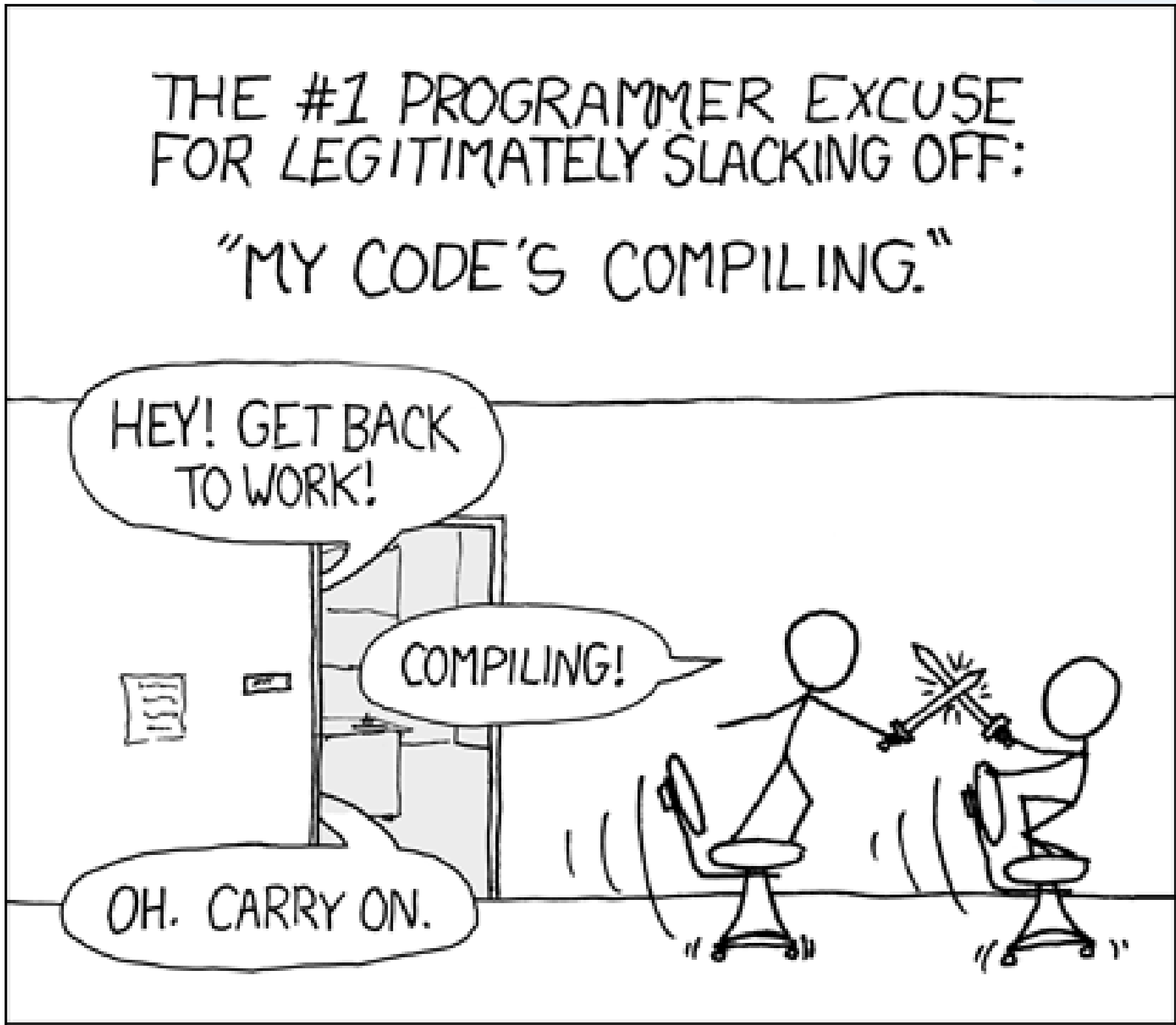
    return 0;
}
```

# Compiling

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++

GNU C Compiler (created 1987).

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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.

# Debugging

What if your code is wrong?

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



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

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

    return 0;
}
```

# Quiz



# Recap

# The End