



```
#include <cstdlib>
#include <iostream>

int main() {
    std::cout << "Hello, world!" << std::endl;
    return EXIT_SUCCESS;
}
```

Introduction to C++

C++ Fundamentals

Agenda

A Bit about C++

C++ Background

- Timeline

- Core Design Principles

C++ Design

- Undefined Behavior

- Turning C++ into Machine Code

- Language Type

- Static Types and Zero-cost Abstractions

Tools

A Bit about C++

What is C++?

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Source Code

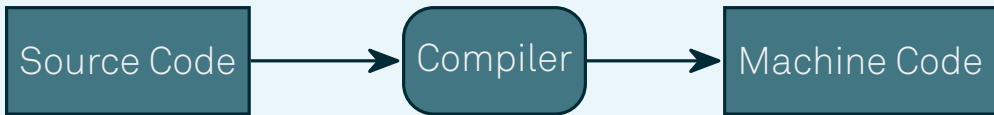
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- Object-oriented programming (OOP)
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C++ Background

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Core Design Principles

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- Every feature should be implementable (with a reasonably obvious way to do so).
- Programmers should be free to pick their own programming style, and that style should be fully supported by C++.
- Allowing a useful feature is more important than preventing every possible misuse of C++.

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- User-created types need to have the same support and performance as built-in types.
- Unused features should not negatively impact created executables (e.g., in lower performance).

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- If the programmer's intent is unknown, allow the programmer to specify it by providing manual control.

Does anything stand out?

C++ Design

Undefined Behavior

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Behavior that has not been defined by the language specification.

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Implications?

- Code may compile, and it may seem like it's working, but it may crash unexpectedly
- Compiler makes no guarantees about what will happen
- Must be avoided

Why allow this?



Performance

Why Undefined Behavior?

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It's faster for the compiler to not worry about every little thing that could go wrong.

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The C motto

Trust the programmer.

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Is this acceptable?

Undefined Behavior and Modern C++

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- Modern solutions which avoid undefined behavior

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- Compiler warnings

Compiled Languages

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Compiled Languages

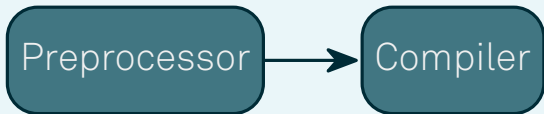
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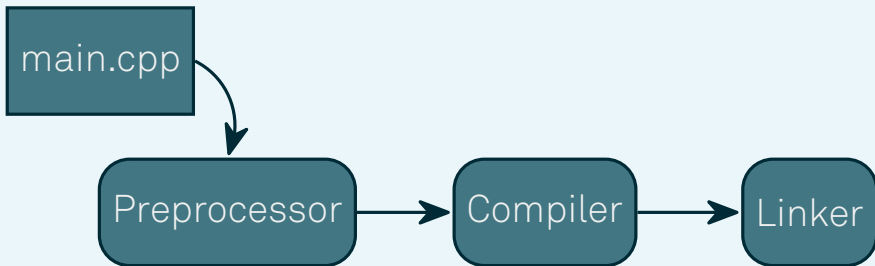
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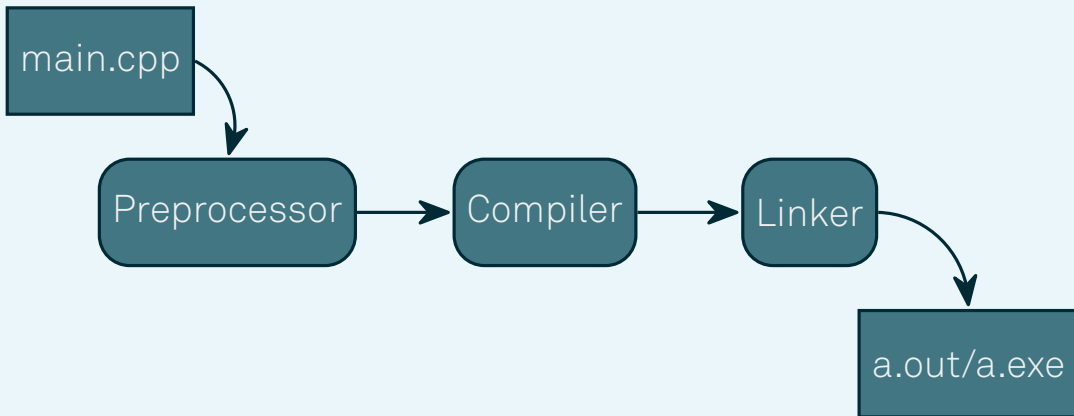
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Machine Code

```
cffa edfe 0700 0001 0300 0000 0200 0000
1100 0000 d805 0000 8580 2100 0000 0000
1900 0000 4800 0000 5f5f 5041 4745 5a45
524f 0000 0000 0000 0000 0000 0000 0000
...
6c65 3500 4743 435f 6578 6365 7074 5f74
6162 6c65 3700 4743 435f 6578 6365 7074
5f74 6162 6c65 3336 0047 4343 5f65 7863
6570 745f 7461 626c 6534 3100 0000 0000
```

Machine code which prints “Hello, world!”.

Assembly Language

```
global _start

section .text

_start:
    mov rax, 1          ; write(
    mov rdi, 1          ;   STDOUT_FILENO,
    mov rsi, msg         ;   "Hello, world!\n",
    mov rdx, msglen      ;   sizeof("Hello, world!\n")
    syscall              ; );

    mov rax, 60         ; exit(
    mov rdi, 0          ;   EXIT_SUCCESS
    syscall              ; );

section .rodata
msg: db "Hello, world!", 10
msglen: equ $ - msg
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x86_64 Assembly which prints “Hello, world!”

Assembly Language

- Language with close correspondence to machine code

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- Human-readable machine code

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C++ is a *middle-level language* compared to C and a *high-level language* compared to Assembly language.

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 - Low level (machine code, Assembly)

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 - Add many abstractions
 - Remove details about hardware control

Language-level Breakdown

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Language-level Breakdown

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 - A lot of hardware control
 - Not many abstractions
 - Middle level (C++)

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Language-level Breakdown

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 - “Smart” memory management

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 - Automated memory management (garbage collector)

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 - TypeScript/JSDoc comments

Zero-cost Abstractions

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Zero-cost Abstractions

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Whether or not we choose to take advantage of abstraction, our code will still be as efficient.



Tools

Our Tools

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