From C to C++

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Why C++ is much more fun than C (C++ FAQ)?

1. Classes & methods - OO design
2. Generic programming - Templates allow for code reuse
3. Function and operator overloading
4. Stricter type system (e.g. function args)
5. Some run-time checks & memory control

A common and mature language that gives you high level and low level control

Have fun ♫

Why C++ is much more fun than C (C++ FQA)?

1. Tons of corner cases
2. Duplicate features
3. Cryptic syntax
4. Undecidable syntax (uncompilable progarms!)
5. No two compilers agree on it

Probably one of the hardest computer languages to master.

Have fun ♪

C++ vs. Java

Java is much simpler to program -
removes many ambiguous and duplicate featues.

So why use C++ at all?

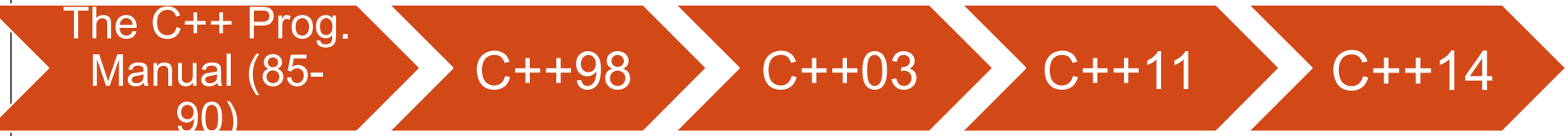
1. *Basis to other languages*. Many other languages and operating systems are written in C/C++ (e.g Java, Python, Windows, Unix/Linux, Mac…).
2. *Understanding*. With C++ you must understand what the computer is doing under the hood.
3. *Zero-cost abstraction.* tight memory and time management – important in embedded systems and real-time systems.
4. *Common in big systems*. Google, Facebook and other big companies use (also) C++.

History

Default in g++

auto, lambdas, threading, …

Auto return type, generic lambdas, binary literals,…



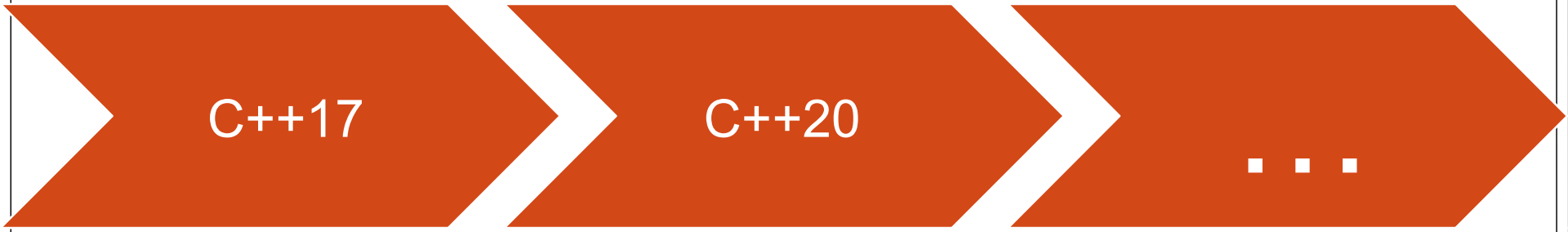
Minor changes

Major changes

Minor changes

We'll learn parts of C++-11, 14, 17,
Mostly parts that makes C++ more "pythonic" while keeping it efficient

Future

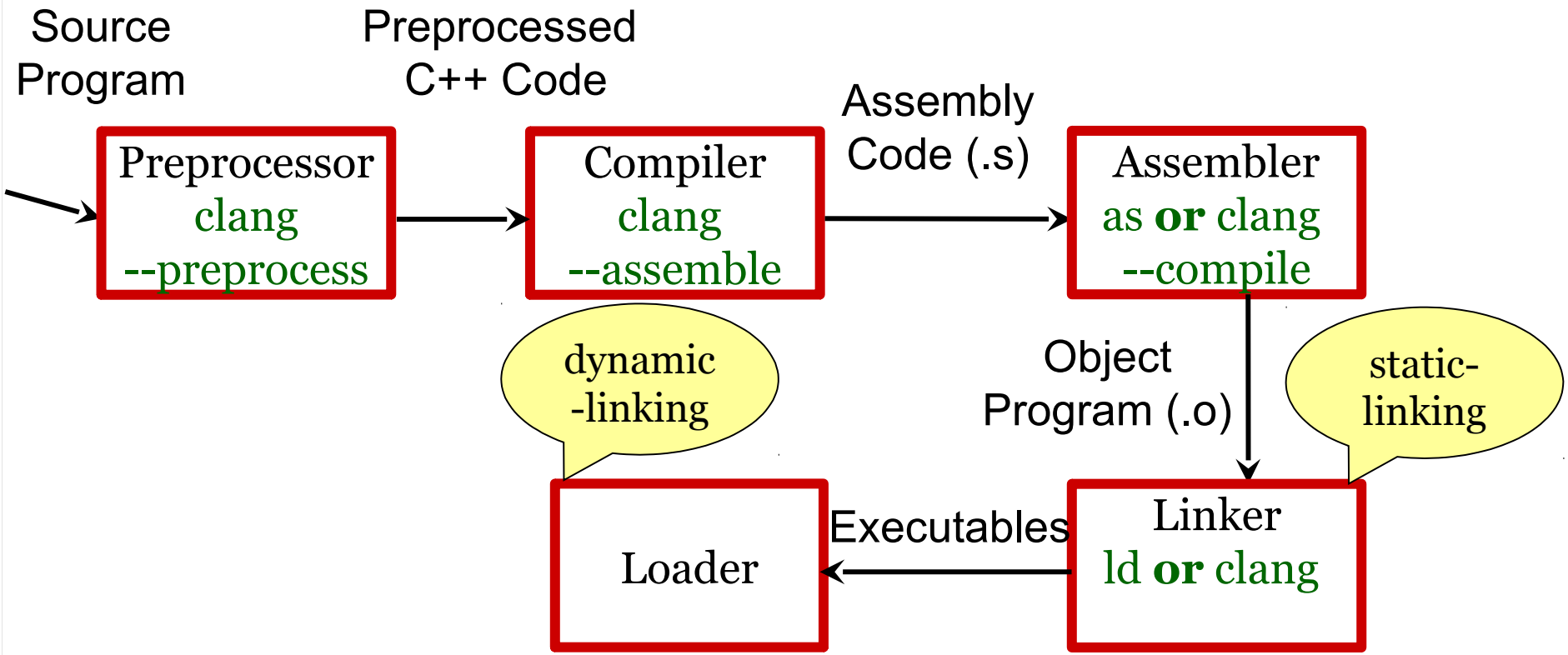


Basic Unix commands

ls
ls -latr
cd [dirname]
mkdir [dirname]
cat [filename]
nano [filename]
grep [word]
source [filename]
rm [filename]

grep … < input.txt
grep ... > output.txt
ls -latr | grep bash

su
exit
sudo apt install ...


Source Program
Preprocessor
clang
--preprocess
Preprocessed C++ Code
Compiler
clang
--assemble
Assembly Code (.s)
Assembler
as or clang
--compile
Object Program (.o)
Linker
ld or clang
Executables
Loader
dynamic -linking
static- linking

The missing types

Fill in missing types from C,
in somewhat crude way

strings in C++

```
#include <iostream>
#include <string>
int main()
{
    std::string str;
    int a;
    double b;
    std::cin >> str >> a >> b;
    if(std::cin.fail())
    {
        std::cerr << "input problem\n";
        return 1;
    }
    std::cout << "I got: "<< str << ' '
    << a << ' ' << b << std::endl;
}
```

:More about string functions

http://www.cppreference.com/cppstring

Boolean variables

```
#include <iostream>
int main()
{
    int a = 5;
    bool isZero = (a == 0);
    // same conditions
    if(!isZero && isZero==false &&
    isZero!=true &&  !!! isZero && a )
    {
        std::cout << "a is not zero\n";
    }
}
```

Good style

C++-11 enum class

```
enum class Season : char {
   WINTER, // = 0 by default
   SPRING, // = WINTER + 1
   SUMMER, // = WINTER + 2
   AUTUMN  // = WINTER + 3
};

Season curr_season;
curr_season= Season::AUTUMN;
curr_season= SUMMER; // won't compile! (good)
curr_season= 19; // won't compile! (good)
int prev_season= Season::SUMMER; // won't compile!
(good)
```

Overloading

Understand and remember.

- More than syntactic sugar.
- This is how a lot of stuff works under the hood (e.g. inheritance)

Function overloading - C

```c
#include <stdio.h>
void foo()
{
   printf ("foo()\n");
}
void foo(int n)
{
   printf ("foo(%d)\n", n);
}
int main()
{
   foo(12);
   foo();
   return 0;
}
```

Compilation output:

Error: Multiple definition of foo

Function overloading – C++

```
#include <iostream>
void foo() {
   std::cout << "foo()\n";
}
void foo(int n) {
   std::cout<<"foo("<<n<<")\n";
}
int main() {
   foo(12);
   foo();
}
```

Output:

Compile, and print:

foo(12)
foo()

Default parameters

```
#include <iostream>

void foo(int n=5)
{
   std::cout << n;
}

int main()
{
      foo();
}
```

Output:

Compile, and print:
foo(5)

Overload resolution

1. Find all functions with same name “candidates”. Let’s call them O1.
2. Find O2 subset of O1 which have the correct number of arguments - “viable candidates”
3. Find O3 subset of O2 with best matching arguments.

```
if |O3|=1
    use that function.
else (0 or more than 1):
    emit compilation error.
```

Inline functions

Inline functions / methods

- A **hint** to a compiler to put function's code inline, rather than perform a regular function call.
When the compiler must produce an address of the function, it will always reject our request.

- Objective: improve **performance** of **small**, frequently used functions.

- An inline function defined in .cpp file is not recognized in other source files.

C vs C++ : macro vs inlining

compare:

```
define SQRT(x) ((x)*(x))
SQRT(i++) // unexpected behavior
```

to

```
inline int sqrt(int x) { return x*x; }
 sqrt(i++) // good behavior
```

Tradeoffs:
Inline vs. Regular Functions / Methods

- Regular functions – when called, compiler stores return address of call, allocates memory for local variables, etc.

- Inline functions – no function call overhead, hence usually faster execution (especially!) as the compiler will be able to optimize *through* the call ("procedural integration").

- Inline functions - code is copied into program in place of call – can enlarge executable program

- Inline functions - can enlarge compile time. You compile the inline function again and again in every place it's used.