Universiteit Utrecht

[Faculty of **Science**
Information and Computing Sciences]

Compiler Construction

Stefan Holdermans

Dept. of Information and Computing Sciences, Utrecht University
P.O. Box 80.089, 3508 TB Utrecht, The Netherlands
E-mail: `stefan@cs.uu.nl`
Web pages: `http://people.cs.uu.nl/stefan/`

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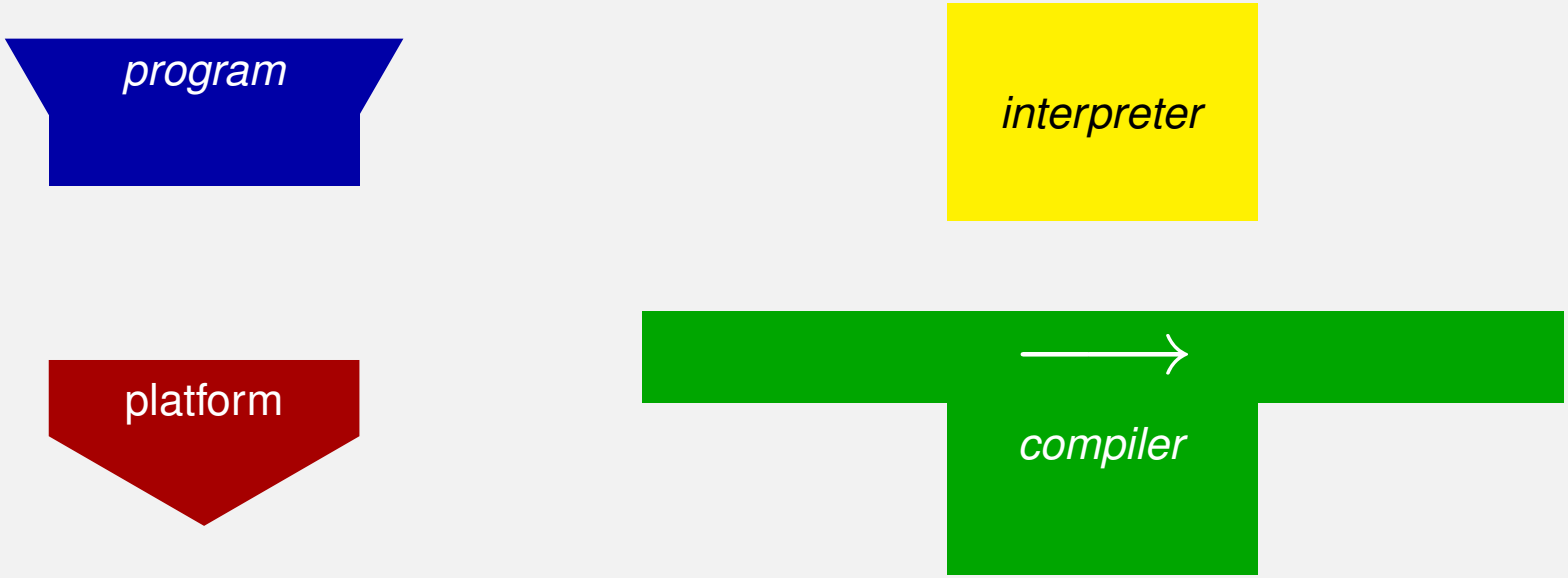
1. Compilers and interpreters

T-diagrams



T-diagrams are a means to visualise the interactions and relationships between programs, platforms, interpreters, and compilers.

Programs

A program *P*, implemented in an implementation language L.

Programs: examples

hello
i686-darwin

msword
i686-windows

hello
i686-linux

ghc
i686-darwin

hello
ppc-darwin

fib
Haskell

Platforms

A (hardware) platform *M*.

Platforms (cont'd)

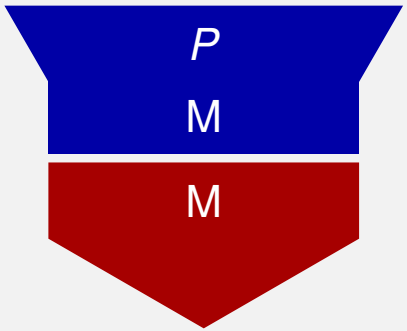
Typically, a platform is a combination of a CPU and an operating system (or, more general, a run-time environment):

- each type of CPU has its own instruction set,
- each operating system has its own conventions for dealing with executables.

Platforms: examples

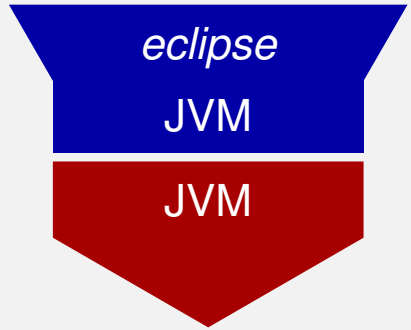
- i686-darwin
- ppc-darwin
- i686-linux
- arm-darwin
- i686-windows
- JVM

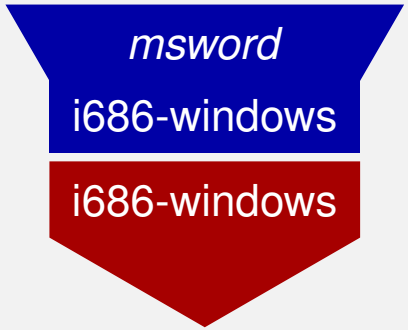
Executing a program



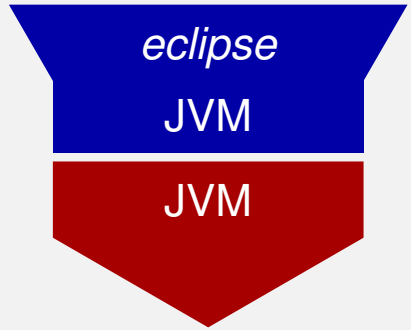
A program *P* can (only) be executed on a platform M if it was implemented in a language that matches M.

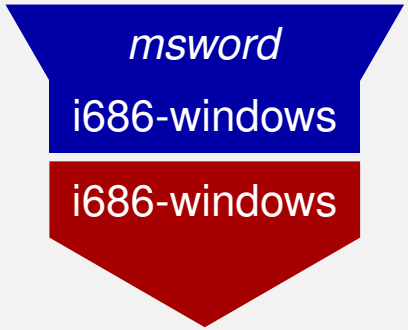
Executing a program: examples





Executing a program: examples





(One cannot just run a program for Mac OS on Windows.)

High-level programming languages

Usually programs are not directly written in the machine language that is supported by the platform on which it is to be executed.

Instead, programs are written in so-called high-level programming languages, such as C, Java, and Haskell.

To execute a program implemented in a high-level language one needs an interpreter for that language. Alternatively, one can use a compiler that translates from the high-level language into the language matched by the target platform.

High-level programming languages: examples §1

hello
Haskell

queens
Java

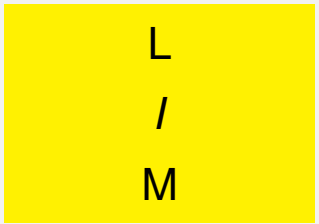
fib
Haskell

sort
Python

hello
C

ghc
Haskell

Interpreters

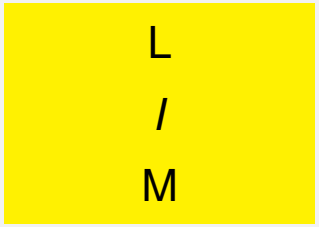


An interpreter / for an object language L,
implemented in an implementation language M.

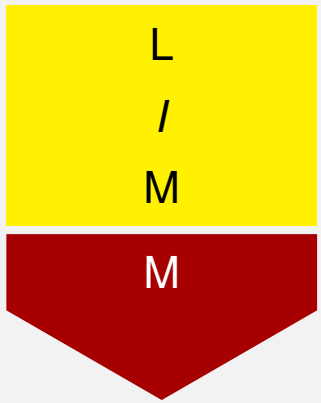
Interpreters: examples

Haskell *hugs* i686-darwin	Python *CPython* i686-linux	JScript *CScript.exe* i686-windows
Haskell *hugs* i686-linux	Perl *perl* i686-linux	VBScript *CScript.exe* i686-windows
Haskell *runghc* i686-darwin	Lua *lua* i686-linux	Ruby *JRuby* JVM

Interpreting a program

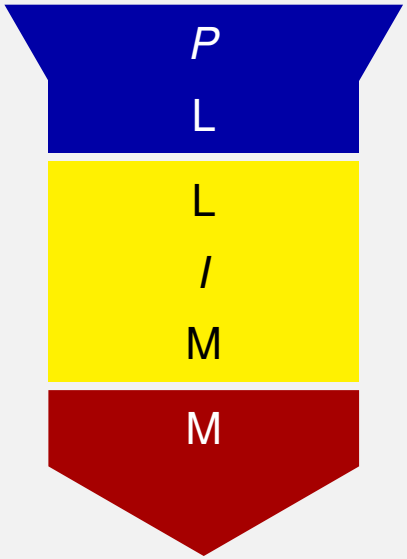


Interpreting a program



An interpreter / for an object langauge L is itself a program that can be executed on a platform for its implementation language M.

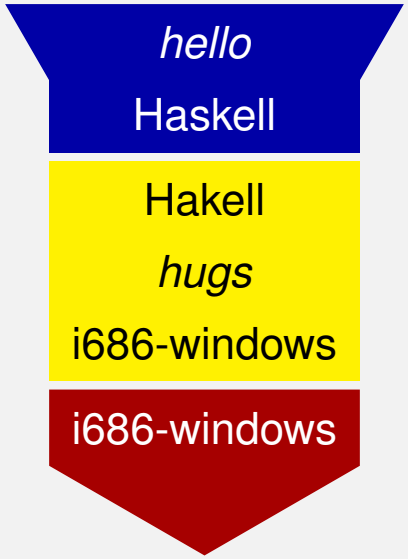
Interpreting a program

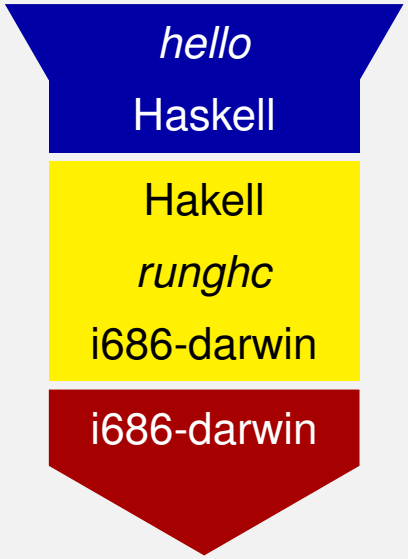


An interpreter *I* for an object langauge L is itself a program that can be executed on a platform for its implementation language M.

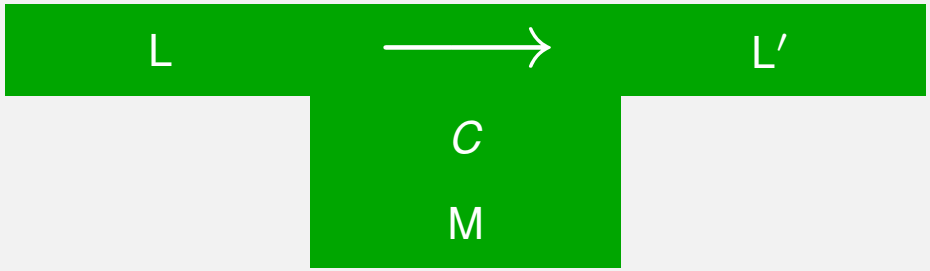
Mediating between L and M, it provides a platform on which programs *P* implemented in *L* can be executed.

Interpreting a program: examples



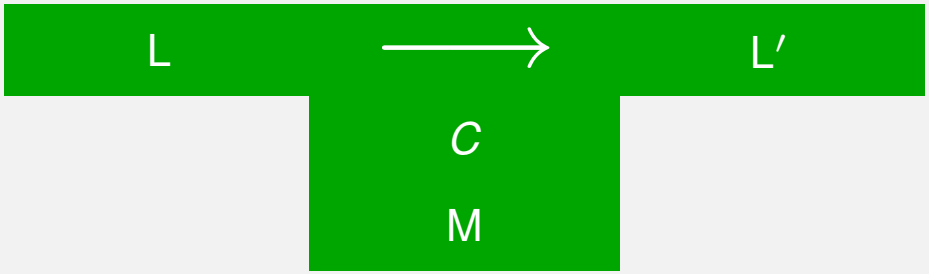


Compilers

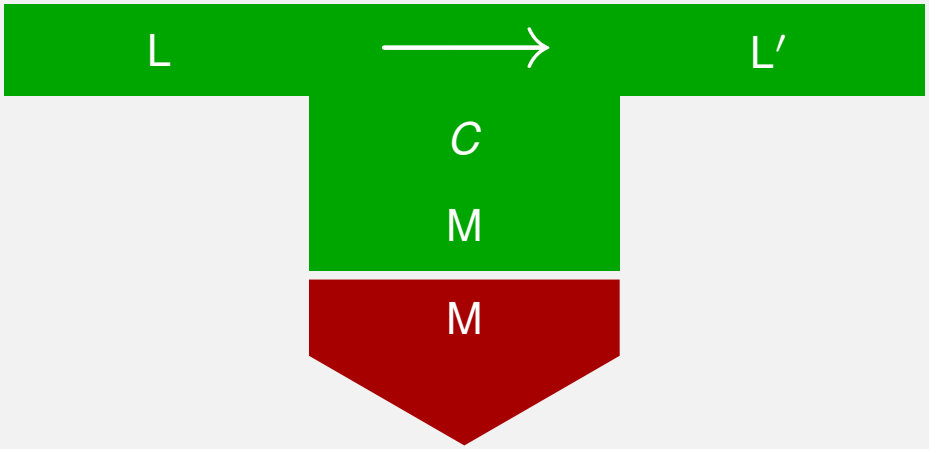


A compiler *C*, implemented in an implementation language M, that translates from a source language L into a target language L′.

Compiling a program

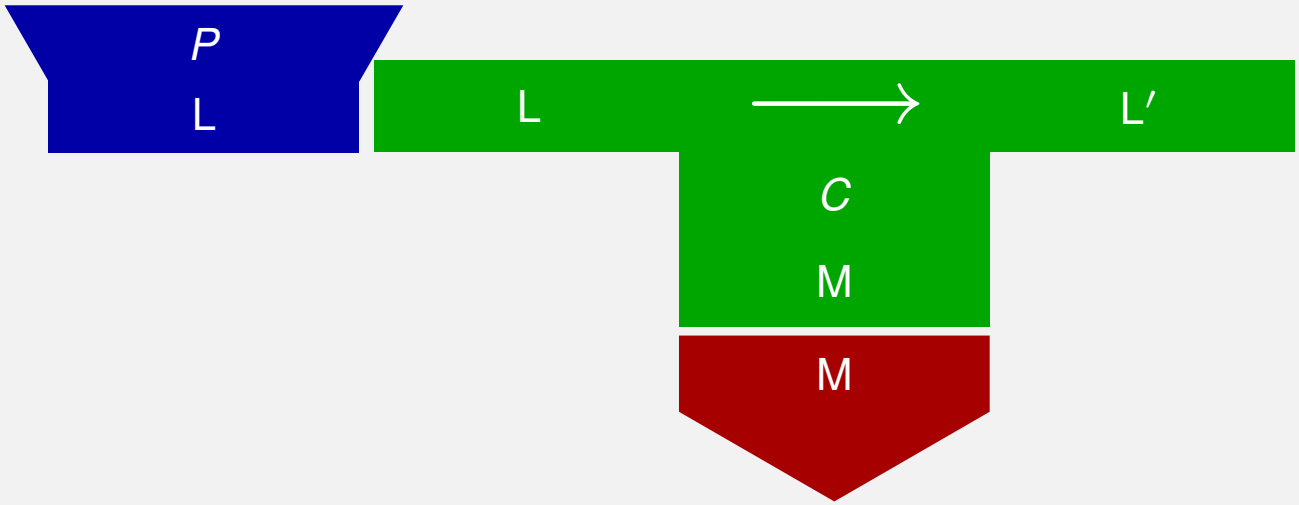


Compiling a program



A compiler *C* for a source language L and a target language L′ is itself a program that can be executed on a platform for its implementation langauge M.

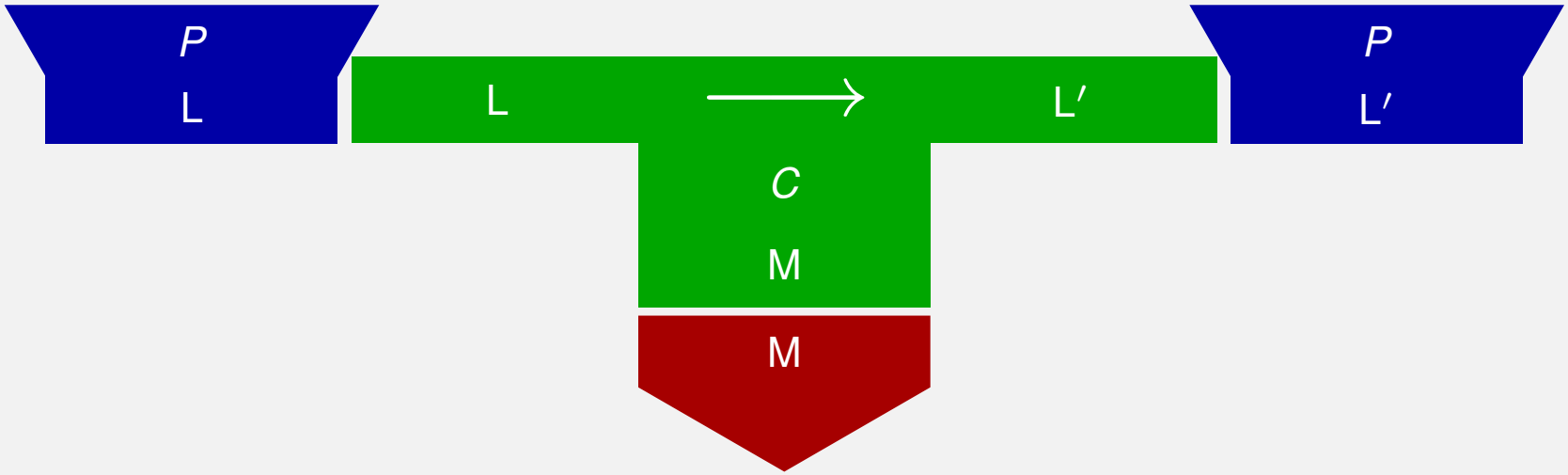
Compiling a program



A compiler *C* for a source language L and a target language L′ is itself a program that can be executed on a platform for its implementation langauge M.

It takes as input a program *P* implemented in L.

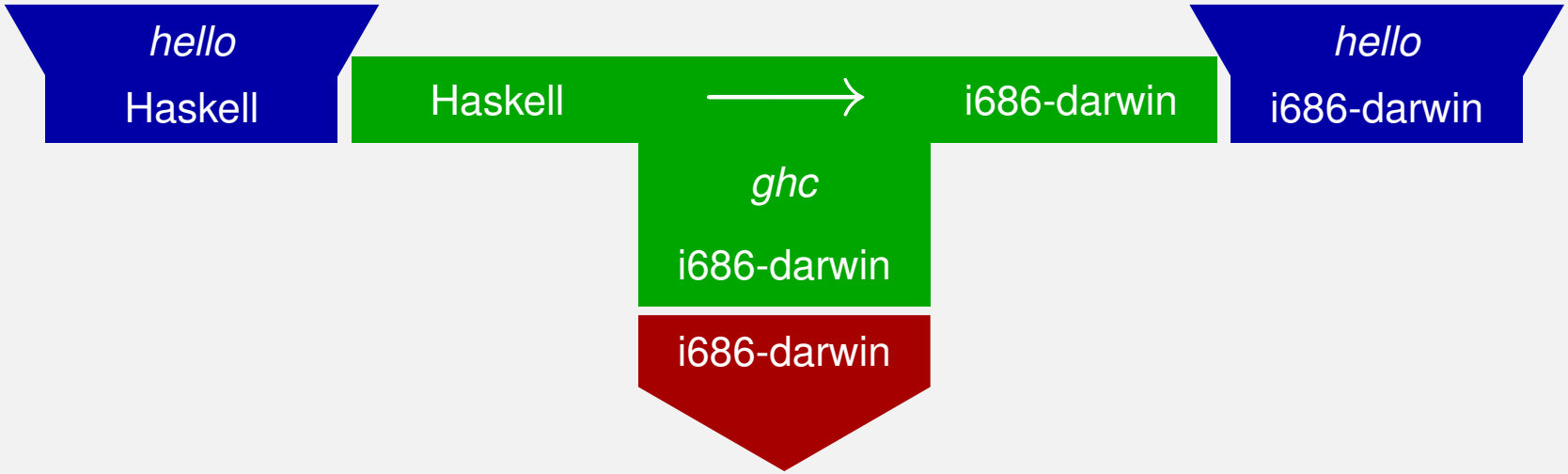
Compiling a program



A compiler *C* for a source language L and a target language L′ is itself a program that can be executed on a platform for its implementation langauge M.

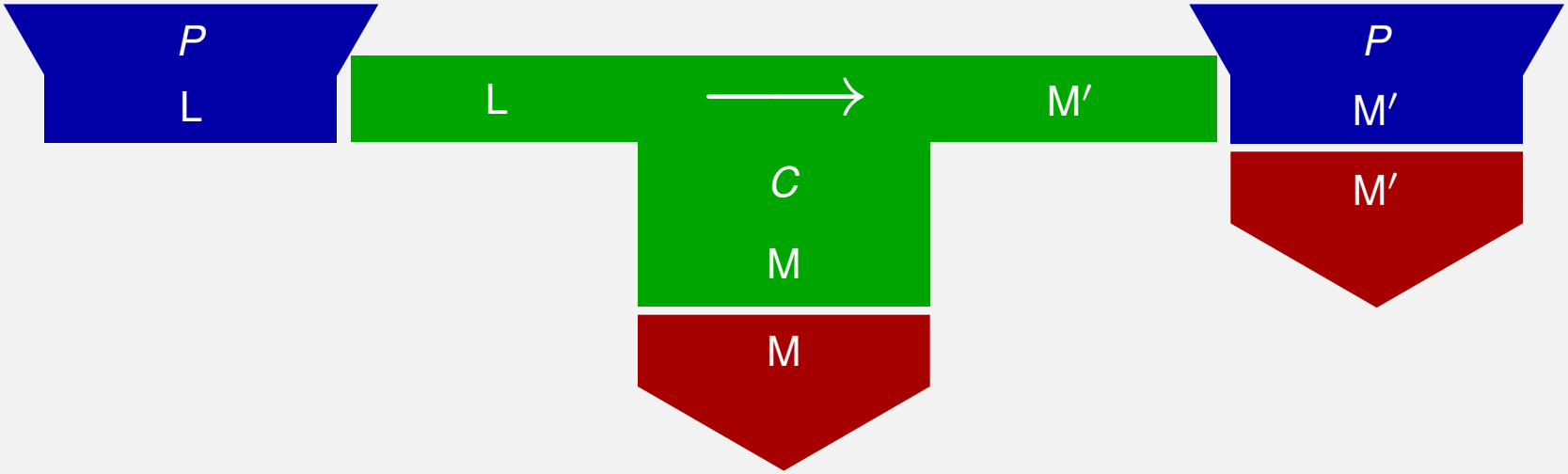
It takes as input a program *P* implemented in L.
It produces as output an implementation of *P* in L′.

Compiling a program: example



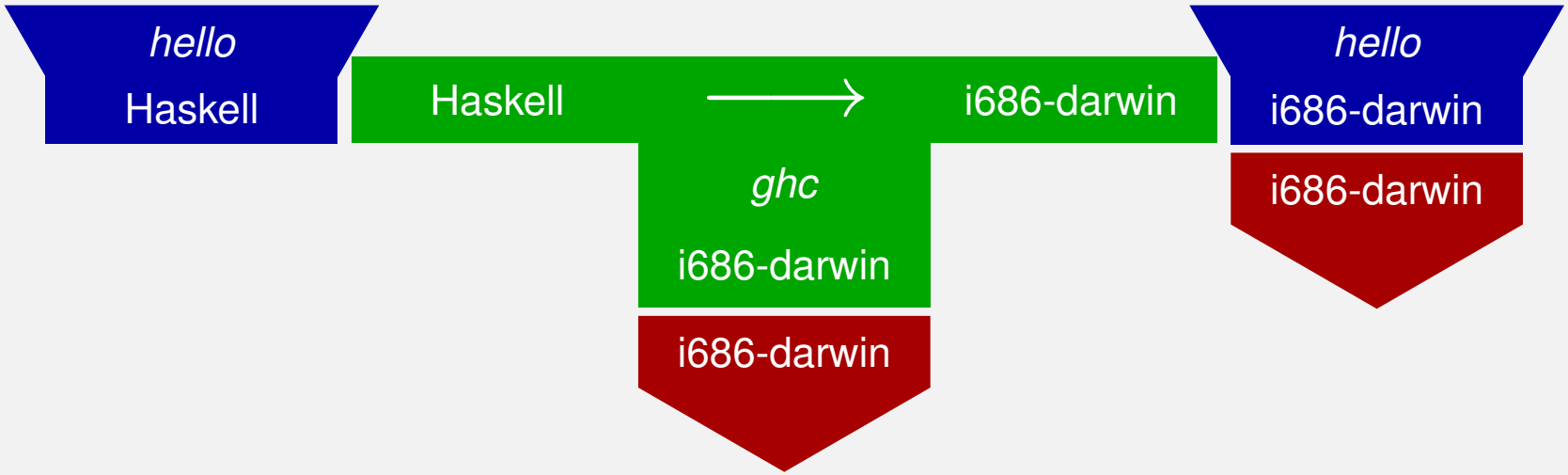
Executables

Often—but not always—the compilation target is a machine-executable program:



Such an executable is a lowest-level representation of the source program for the target platform and consists of instructions that can be directly executed by the target machine. Hence, execution can be very fast.

Executables: example



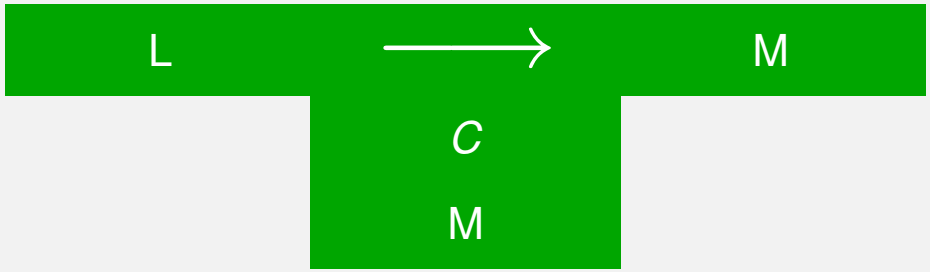
Nonexecutable targets

The target of a compiler need not be an executable; any target language will do.

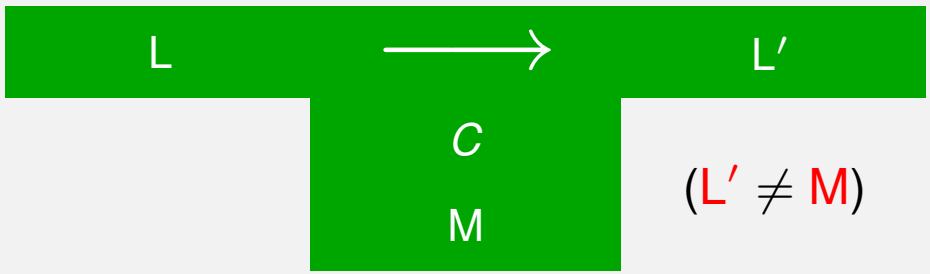
A compiler that translates from one high-level language into another is called a source-to-source compiler.

Cross compilers

Often, a compiler is targeted at the same platform it runs on, i.e., its implementation language and target language are the same:



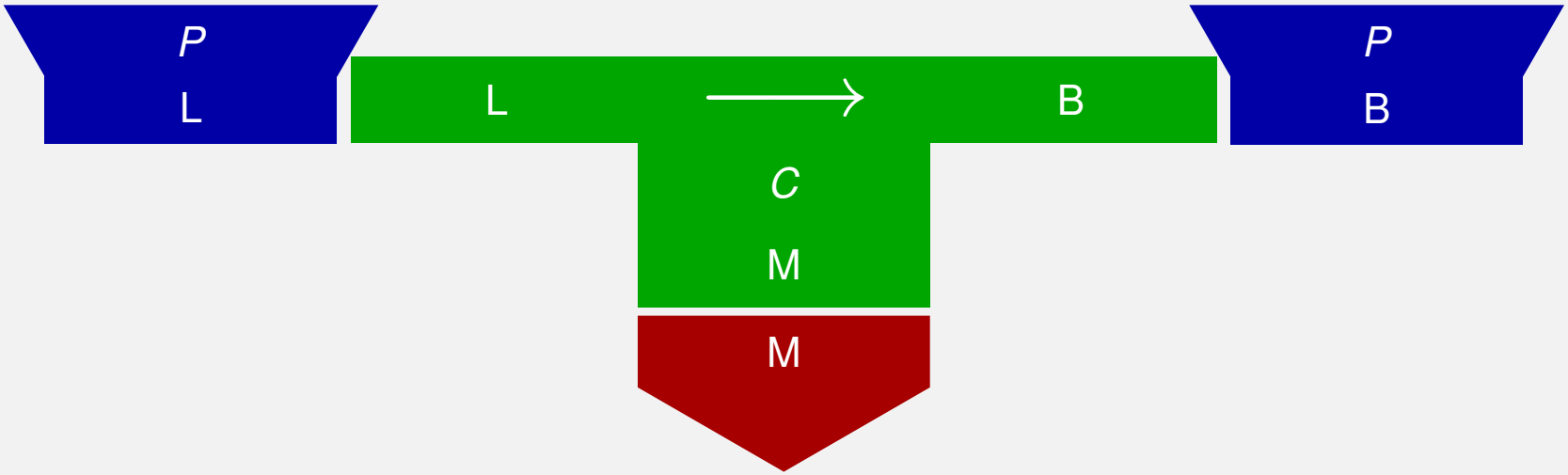
A compiler that generates code for a platform other than the one it runs on itself, is called a cross compiler:



$(L' \neq M)$

Virtual machines

As an alternative to producing machine-executable code directly, sometimes a source program implemented in a high-level programming language is translated into low-level byte code for a so-called virtual machine:



Virtual machines

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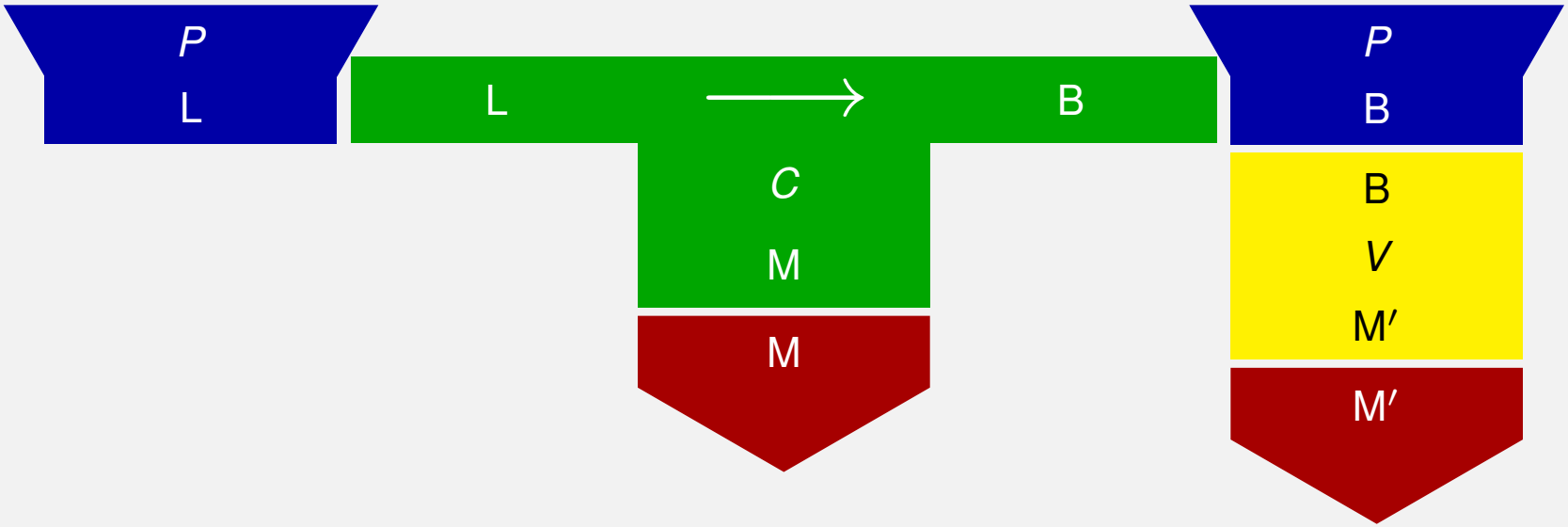

The virtual machine is not a real hardware platform: it is implemented as a byte-code interpreter.

Virtual machines: example

The Java Virtual Machine: