Programming Languages

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January 23, 2023

Language Implementation Methods

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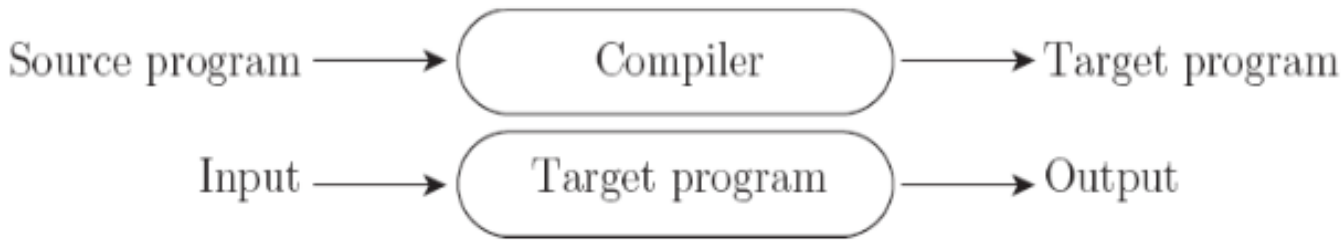
Hybrid Implementation Systems

A compromise between compilers and pure interpreters.

Pure Compilation

The compiler translates the high-level source program into an equivalent target program (typically in machine language), and then goes away.



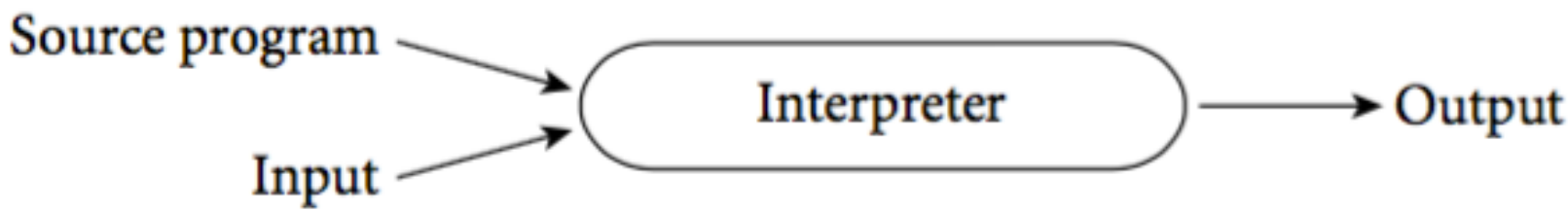
Example

C (compiled)

```
$ gcc hello.c -o hello /*Compile source hello.c into tar*/
$ ls
hello hello.c
$ ./hello  /* Execute target program ‘‘hello’’*/
Hello World
```

Pure Interpretation

- Interpreter stays around for the execution of the program.
- Interpreter is the point of control during execution.



Examples

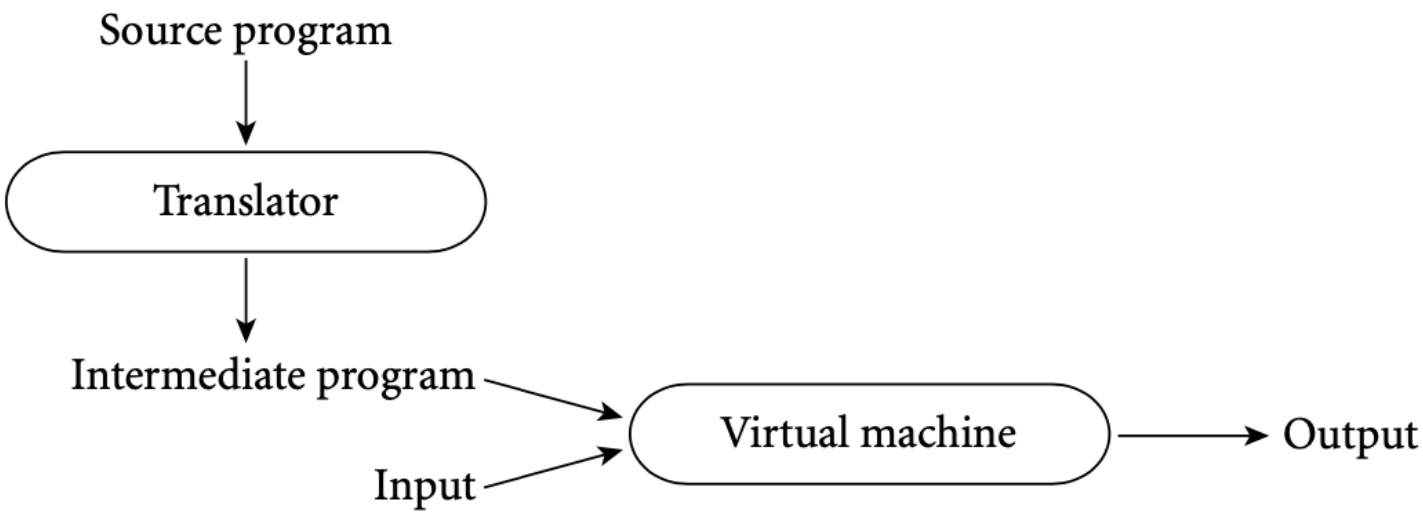
Python (in interactive mode – interpreted)

```
$ python
>>> x = ‘‘Hello, world! ’’
>>> y = 4
>>> y*x
‘Hello, world! Hello, world! Hello, world! Hello, world! ’
>>> x+y

Traceback (most recent call last):
     File ‘‘<stdin>", line 1, in <module>
TypeError: cannot concatenate ‘str’ and ‘int’ objects
```

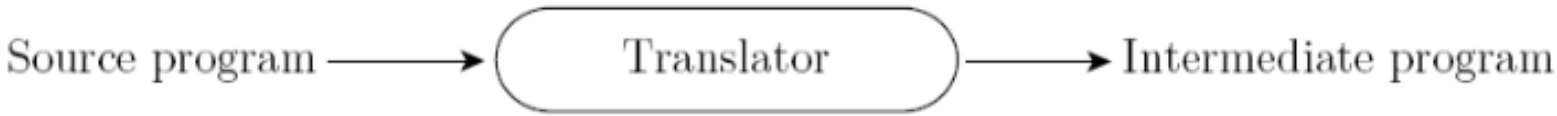
Hybrid

Most language implementations include a mixture of both compilation and interpretation.



Compilation vs. Interpretation

- Common case is compilation or simple pre-processing, followed by interpretation.
- Most language implementations include a mixture of both compilation and interpretation.



Example

Java

```
$ javac Hello.java
//  javac compiler produces byte code ‘‘.class’’ file
$ ls
Hello.class Hello.java
$ java Hello Hello, world!
```

The Java Virtual Machine, or JVM (a “just-in-time” compiler), converts bytecode “on the fly” into machine code. (Opinions vary on whether to call this an interpreter!)

Compilation vs. Interpretation

Interpretation:

- Greater flexibility.
- Better diagnostics (error messages), easier to debug.
- E.g., programmer can decide what to do next based on output seen so far.

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Compilation:

- Better performance.
- Privacy of the original code.
- Can consider whole program at once, optimize based on things like "remove unnecessary commands from loop body".

Making of a Programming Language

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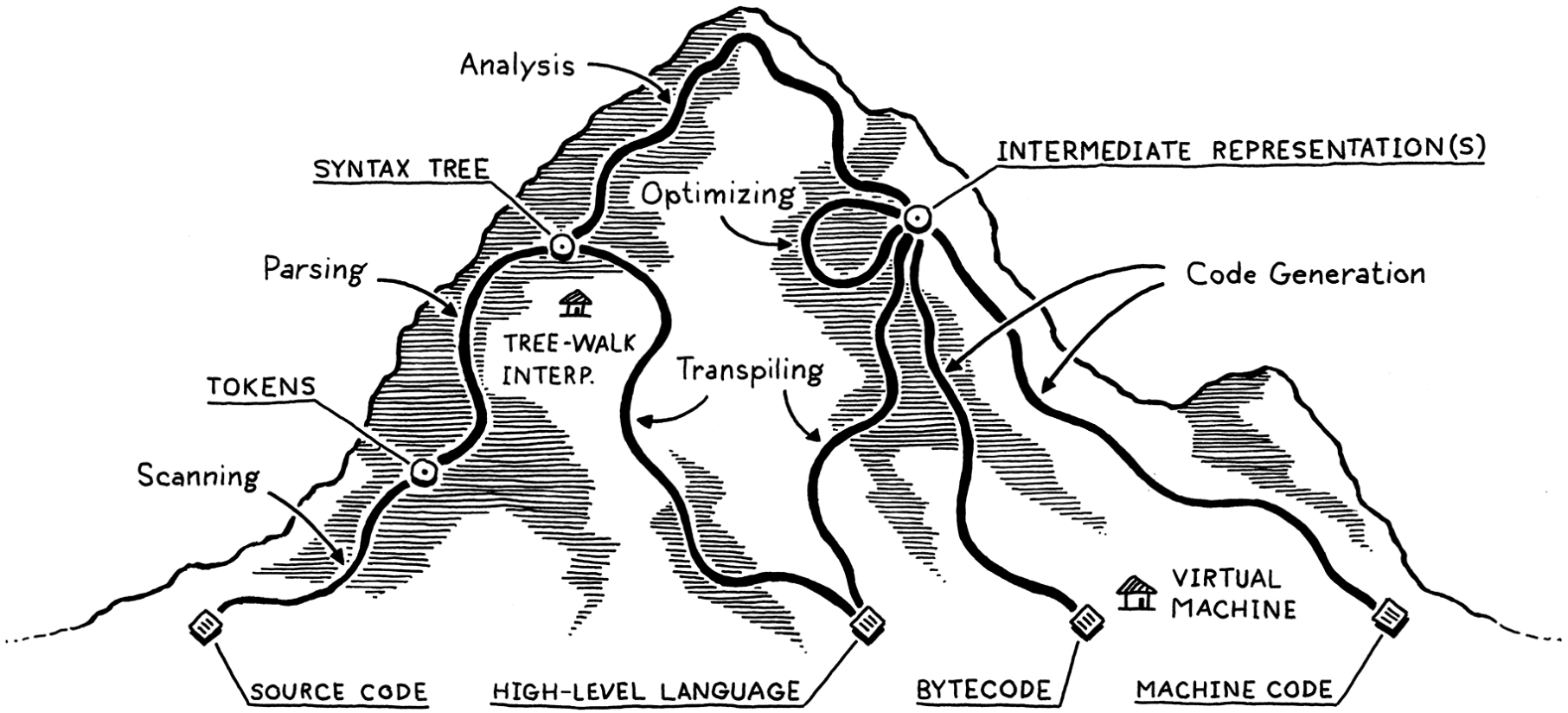
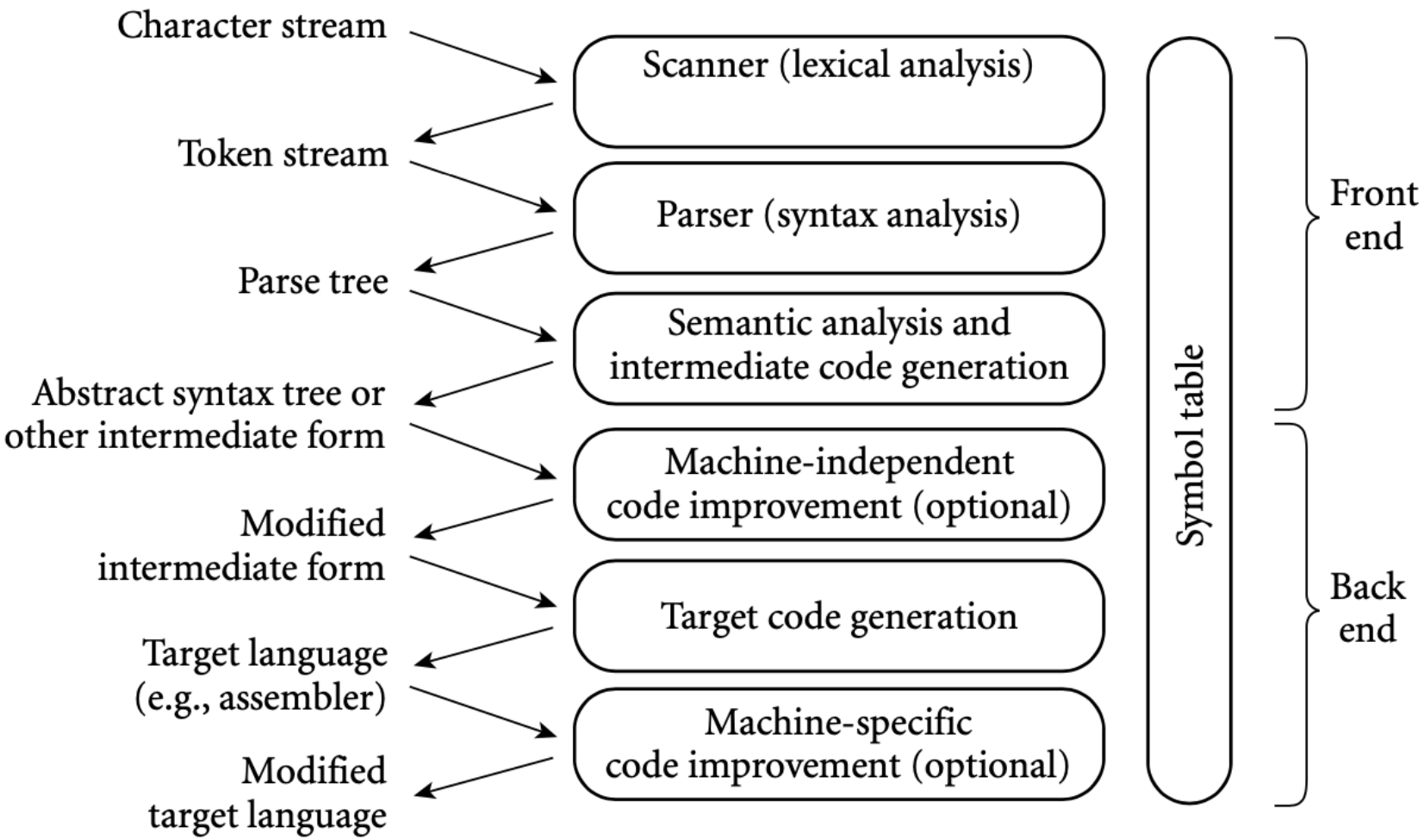


Most Important Steps in Compilation



Other Steps Possible

- Pre-processing prior to or in conjunction with lexical analysis.
- Final machine-specific optimization step.