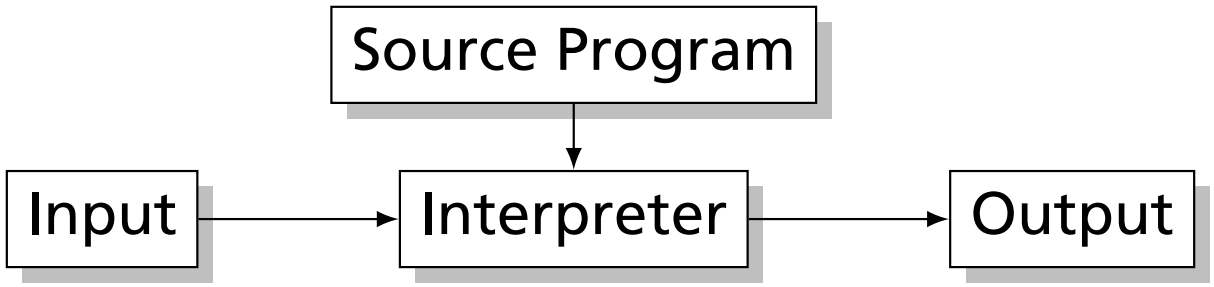
Language Processors

Stephen A. Edwards

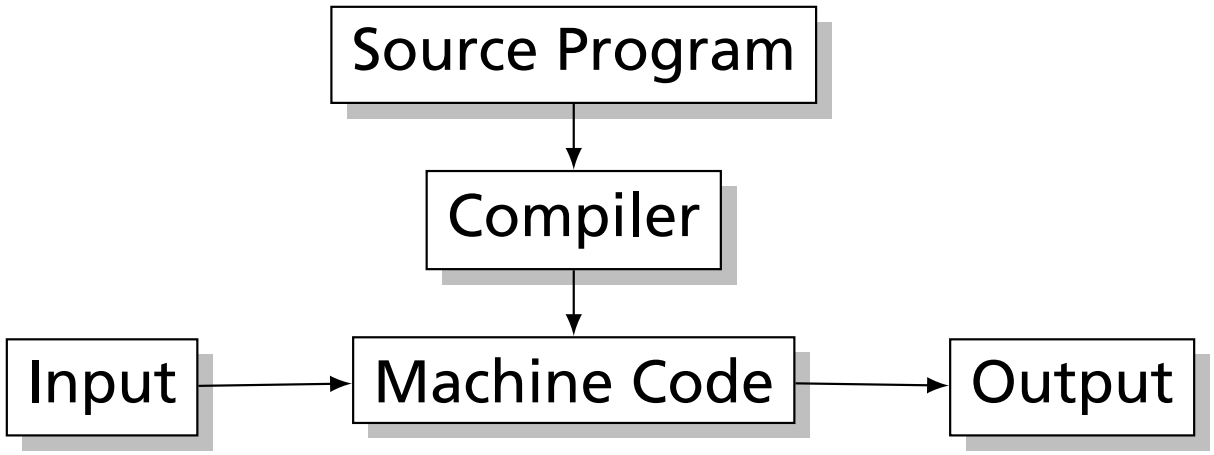
Columbia University

Fall 2018

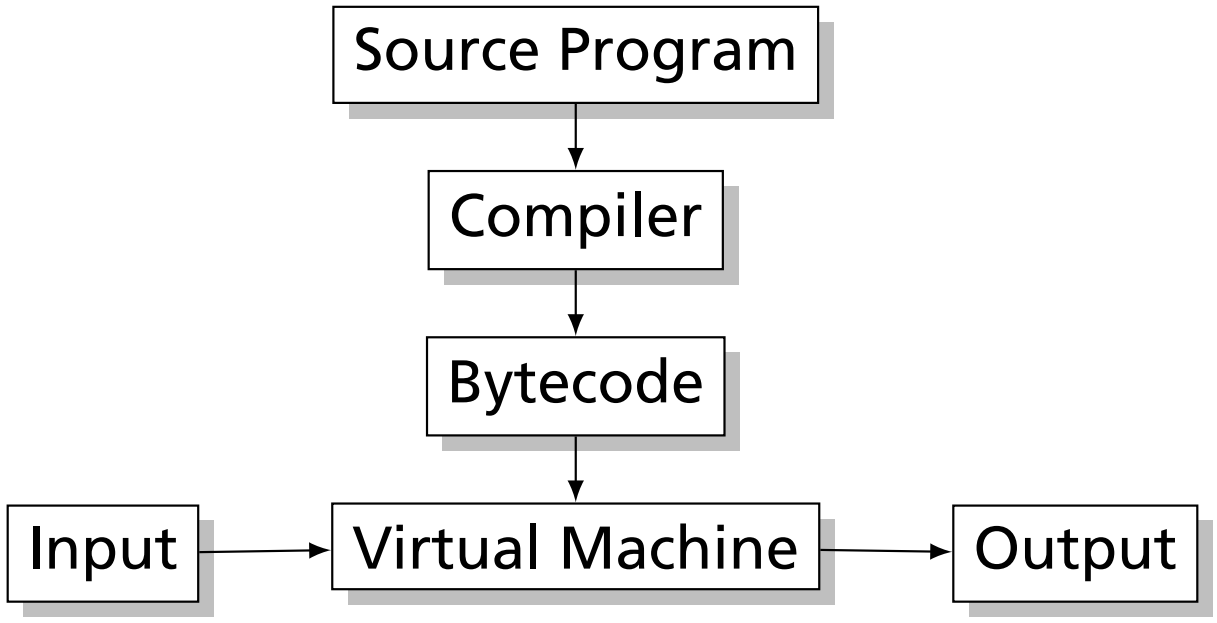
Interpreter



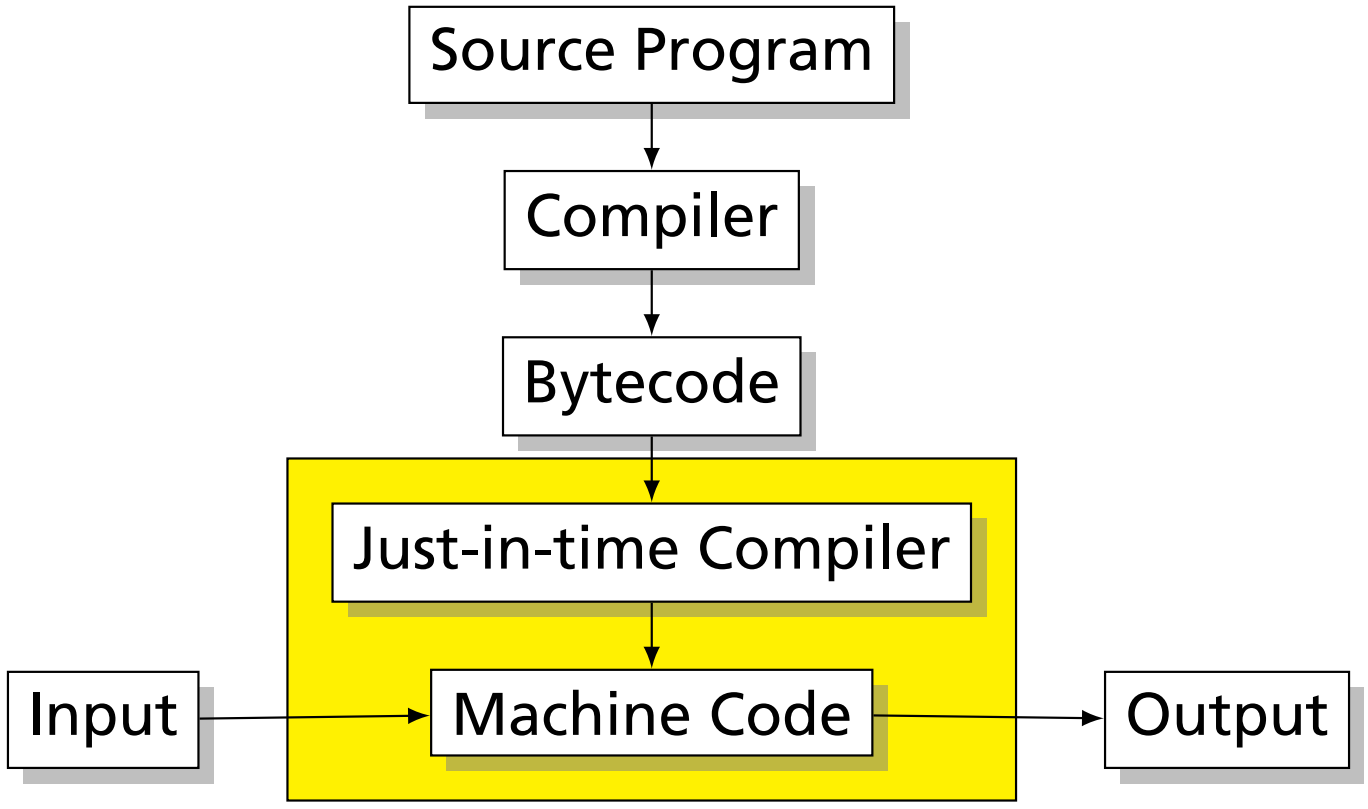
Compiler



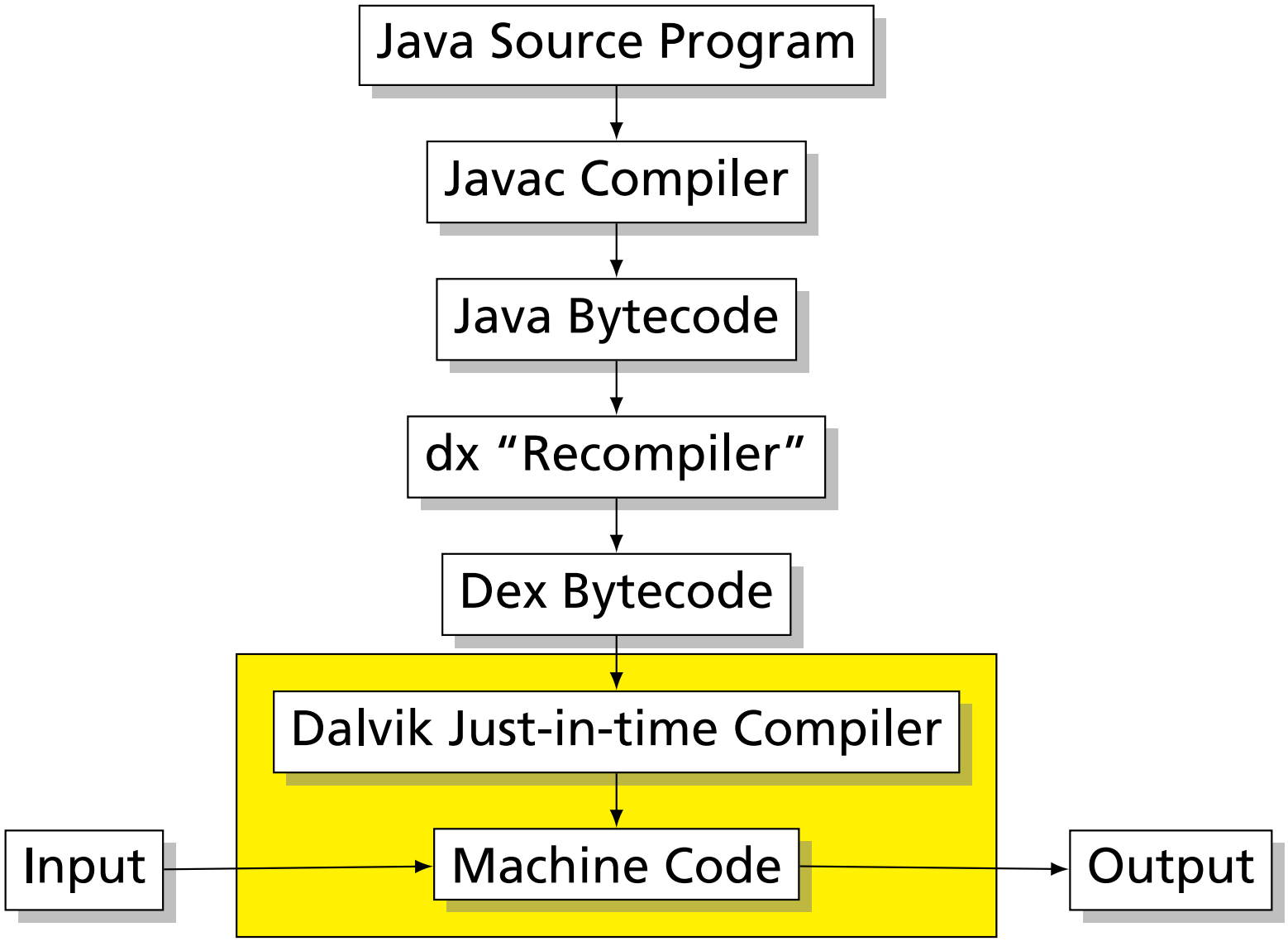
Bytecode Interpreter



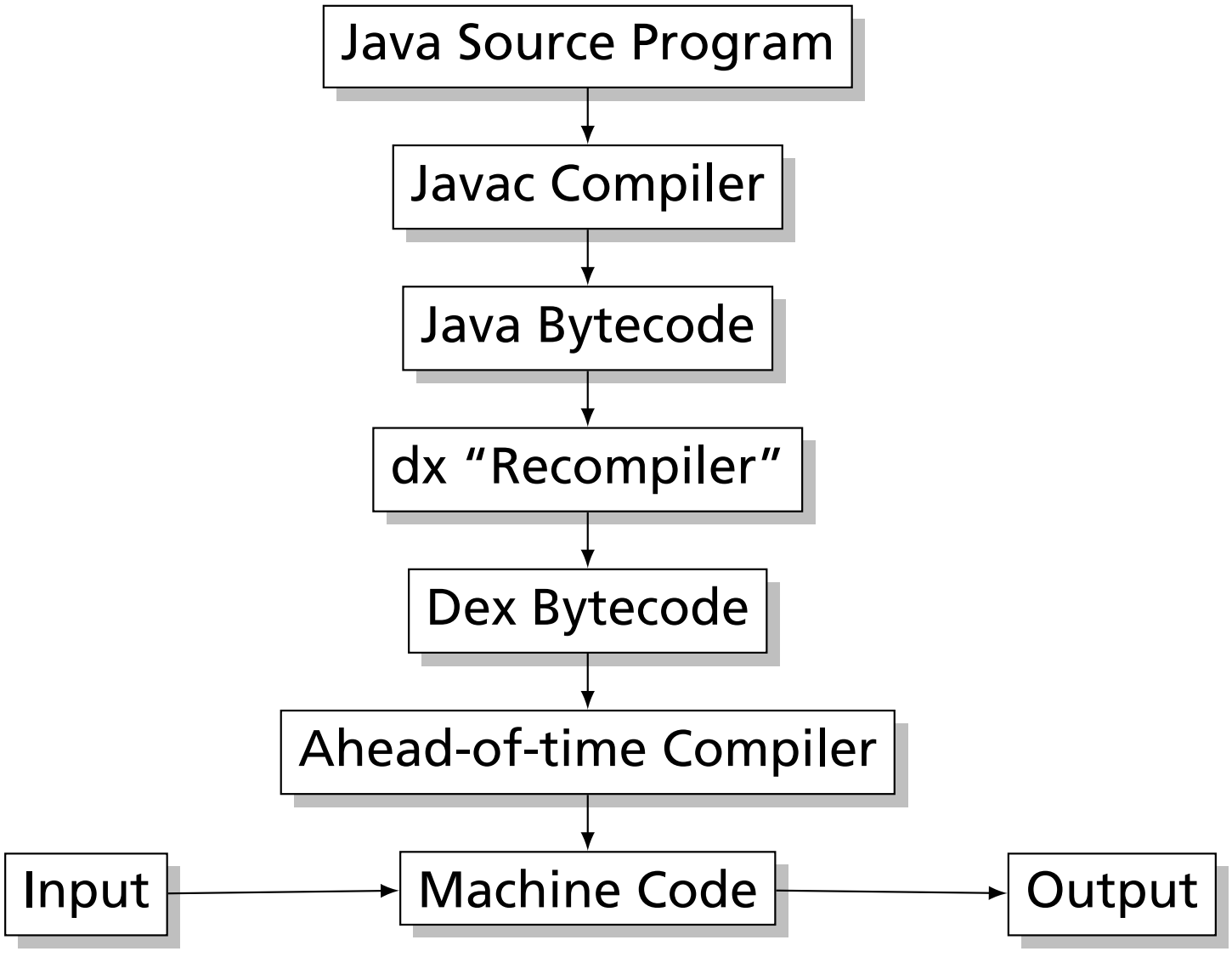
Just-In-Time Compiler



Android 4.4 KitKat and earlier



Android 5.0 Lollipop



Jared Pochtar ▸ Stephen A. Edwards

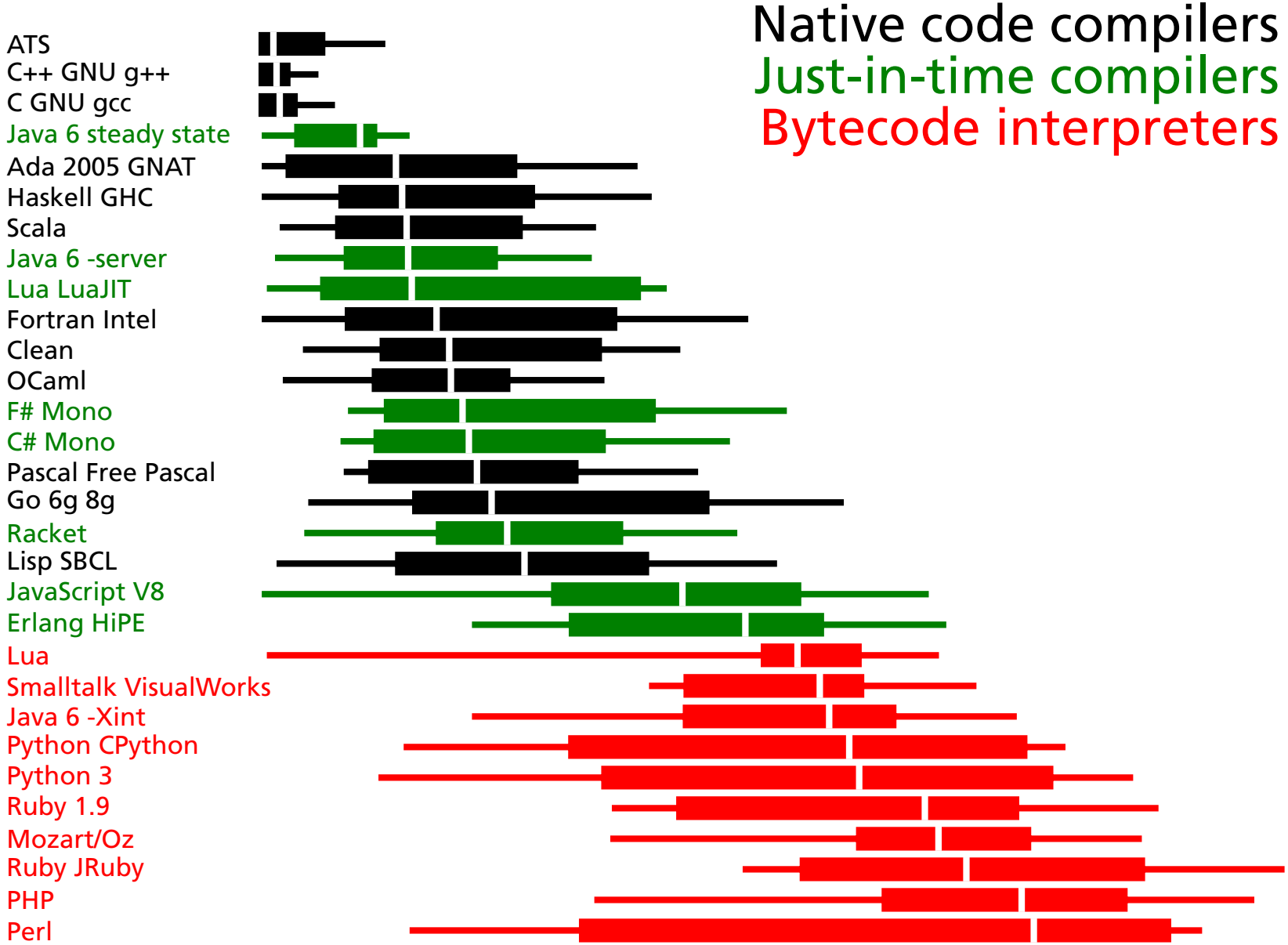
December 1, 2015 at 9:33pm · Cambridge, MA ·

I know you've gotten to me when I go to Chipotle and think, hey, this is just a 5-stage pipeline English to burrito compiler

Like Comment Share

You, Michael Turner and 7 others

Language Speeds Compared



Source: http://shootout.alioth.debian.org/

Compiling a Simple Program

```
int gcd(int a, int b)
{
  while (a != b) {
    if (a > b) a -= b;
    else b -= a;
  }
  return a;
}
```

What the Compiler Sees

```
int gcd(int a, int b)
{
  while (a != b) {
    if (a > b) a -= b;
    else b -= a;
  }
  return a;
}
```

```
i  n  t sp  g  c  d  (  i  n  t sp  a  , sp  i
n  t sp  b  ) nl  { nl sp sp  w  h  i  l  e sp
(  a sp  !  = sp  b  ) sp  { nl sp sp sp sp  i
f sp  (  a sp  > sp  b  ) sp  a sp  -  = sp  b
; nl sp sp sp sp  e  l  s  e sp  b sp  -  = sp
a  ; nl sp sp  } nl sp sp  r  e  t  u  r  n sp
a  ; nl  } nl
```

Just a sequence of characters

Lexical Analysis Gives Tokens

```
int gcd(int a, int b)
{
  while (a != b) {
    if (a > b) a -= b;
    else b -= a;
  }
  return a;
}
```

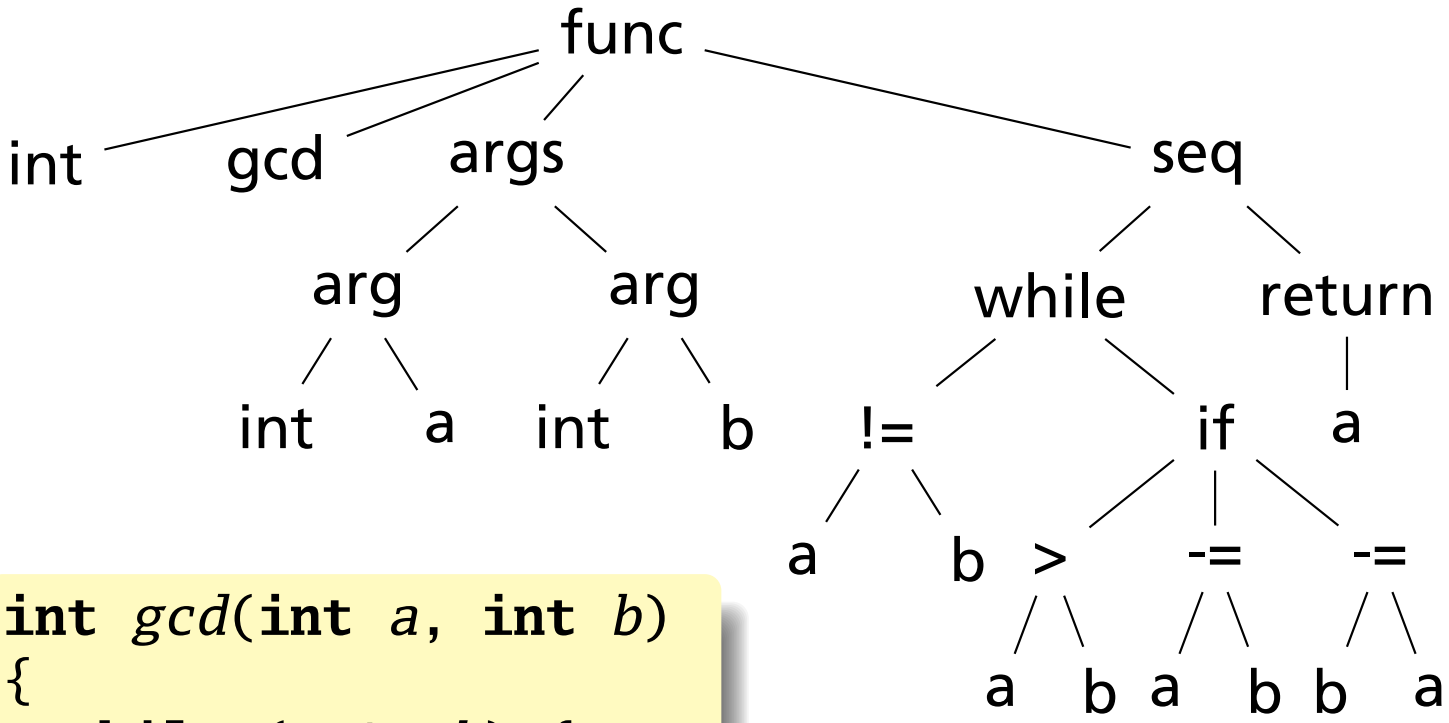
`int` `gcd` `(` `int` `a` `,` `int` `b` `)` `{` `while` `(` `a`

`!=` `b` `)` `{` `if` `(` `a` `>` `b` `)` `a` `-=` `b` `;` `else`

`b` `-=` `a` `;` `}` `return` `a` `;` `}`

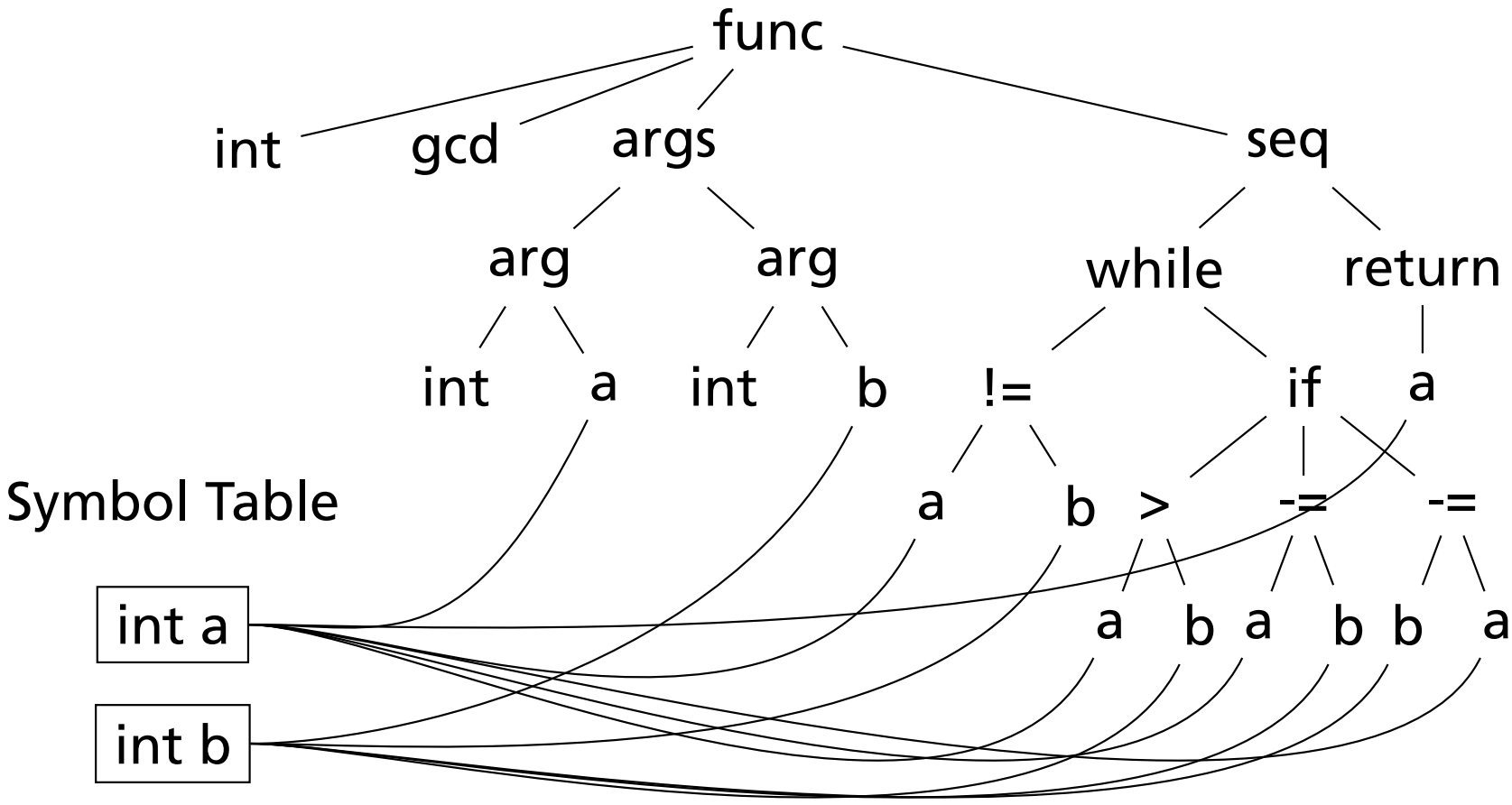
A stream of tokens. Whitespace, comments removed.

Parsing Gives an Abstract Syntax Tree




```
int gcd(int a, int b)
{
  while (a != b) {
    if (a > b) a -= b;
    else b -= a;
  }
  return a;
}
```

Semantic Analysis: Resolve Symbols; Verify Types



Translation into 3-Address Code

```
L0: sne   $1,  a, b
    seq   $0, $1, 0
    btrue $0, L1    # while (a != b)
    sl    $3,  b, a
    seq   $2, $3, 0
    btrue $2, L4    # if (a < b)
    sub   a,   a, b # a -= b
    jmp   L5
L4: sub   b,   b, a # b -= a
L5: jmp   L0
L1: ret   a
```

```
int gcd(int a, int b)
{
  while (a != b) {
    if (a > b) a -= b;
    else b -= a;
  }
  return a;
}
```

Idealized assembly language w/ infinite registers

Generation of 80386 Assembly

```
gcd:   pushl %ebp              # Save BP
       movl  %esp,%ebp
       movl  8(%ebp),%eax      # Load a from stack
       movl  12(%ebp),%edx     # Load b from stack
.L8:   cmpl  %edx,%eax
       je    .L3               # while (a != b)
       jle   .L5               # if (a < b)
       subl  %edx,%eax         # a -= b
       jmp   .L8
.L5:   subl  %eax,%edx         # b -= a
       jmp   .L8
.L3:   leave                   # Restore SP, BP
       ret
```

```
int gcd(int a, int b)
{
  while (a != b) {
    if (a > b) a -= b;
    else b -= a;
  }
  return a;
}
```