Language Processors

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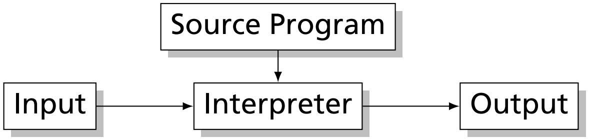
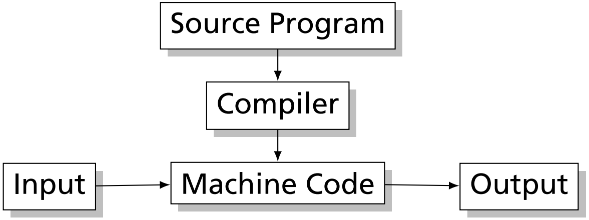
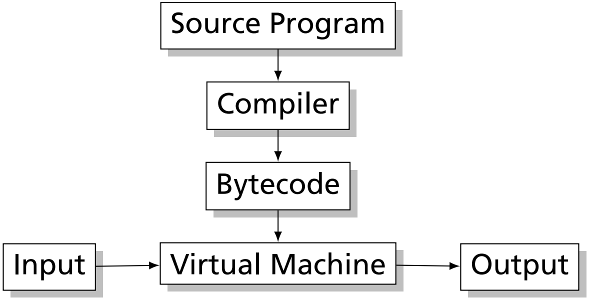
Interpreter



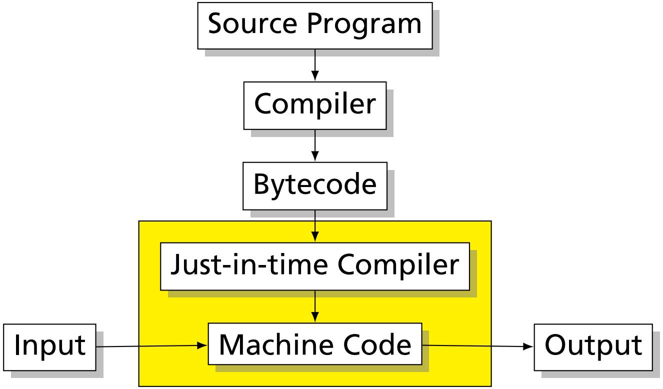
Compiler



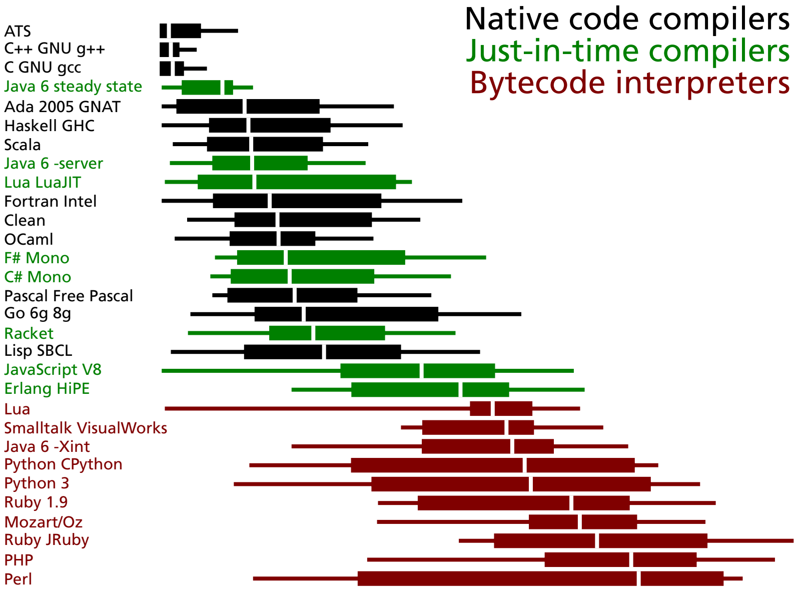
Bytecode Interpreter



Just-In-Time Compiler



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

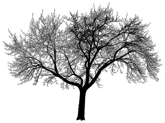
Lexical Analysis Gives Tokens

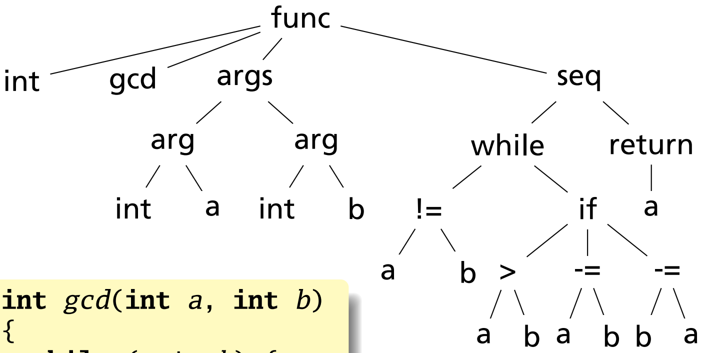
```
int gcd(int a, int b)
{
  while (a != b) {
    if (a > b) a -= b;
    else b -= a;
  }
  return a;
}
```

```
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.

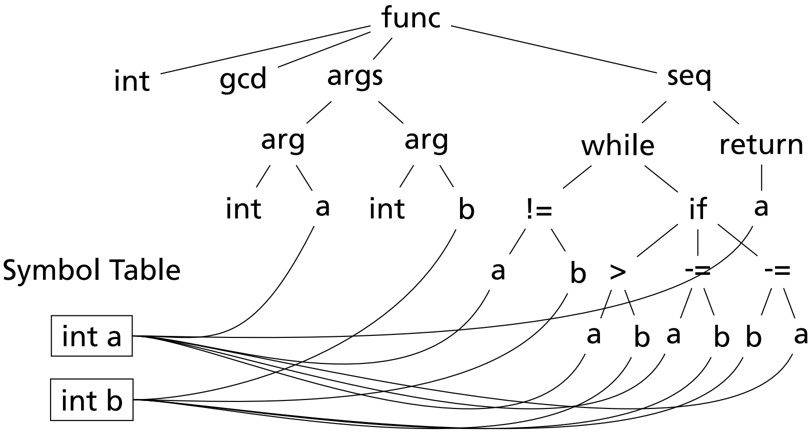
Parsing Gives an Abstract Syntax Tree





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

Semantic Analysis Resolves Symbols and Checks 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;
}
```