CS480
Translators

Introduction to Compilers

Chap. 1

What are translators?

- Compiler
- Interpreter
- Mixed

- Programming Language Examples?
- Bill Kinnersley has site on history of languages: http://people.ku.edu/~nkinners/LangList/Extras/langlist.htm

A Short History of Compilers

- First, there was nothing.
- Then, there was machine code.
- Then, there were assembly languages.
- Then, there came higher-level languages.
- Then, fourth-generation languages.
- Lastly, fifth-generation languages.

Why Study Compilers?

- Excellent software-engineering example --- theory meets practice.
- Essential software tool.
- Influences hardware design, RISC vs. CISC.
- Tools (mostly “optimization”) for enhancing software reliability and security.

John Backus

- “I’m a terribly unscholarly person, and lazy. That was my motivating force in most of what I did, was how to avoid work.”
- Led the team that developed widely used high-level programming language (FORTRAN)
- Well known for Backus-Naur Form (BNF)

From Description to Implementation

- **Lexical analysis:** Identify logical pieces of description
- **Syntax analysis:** Identify how those pieces relate to each other.
- **Semantic analysis:** Identify the meaning of those relations.
- **IR Optimization:** Simplify the intended structure.
- **Code Generation:** Fabricate the structure**.**
- **Optimization:** Improve the resulting structure**.**

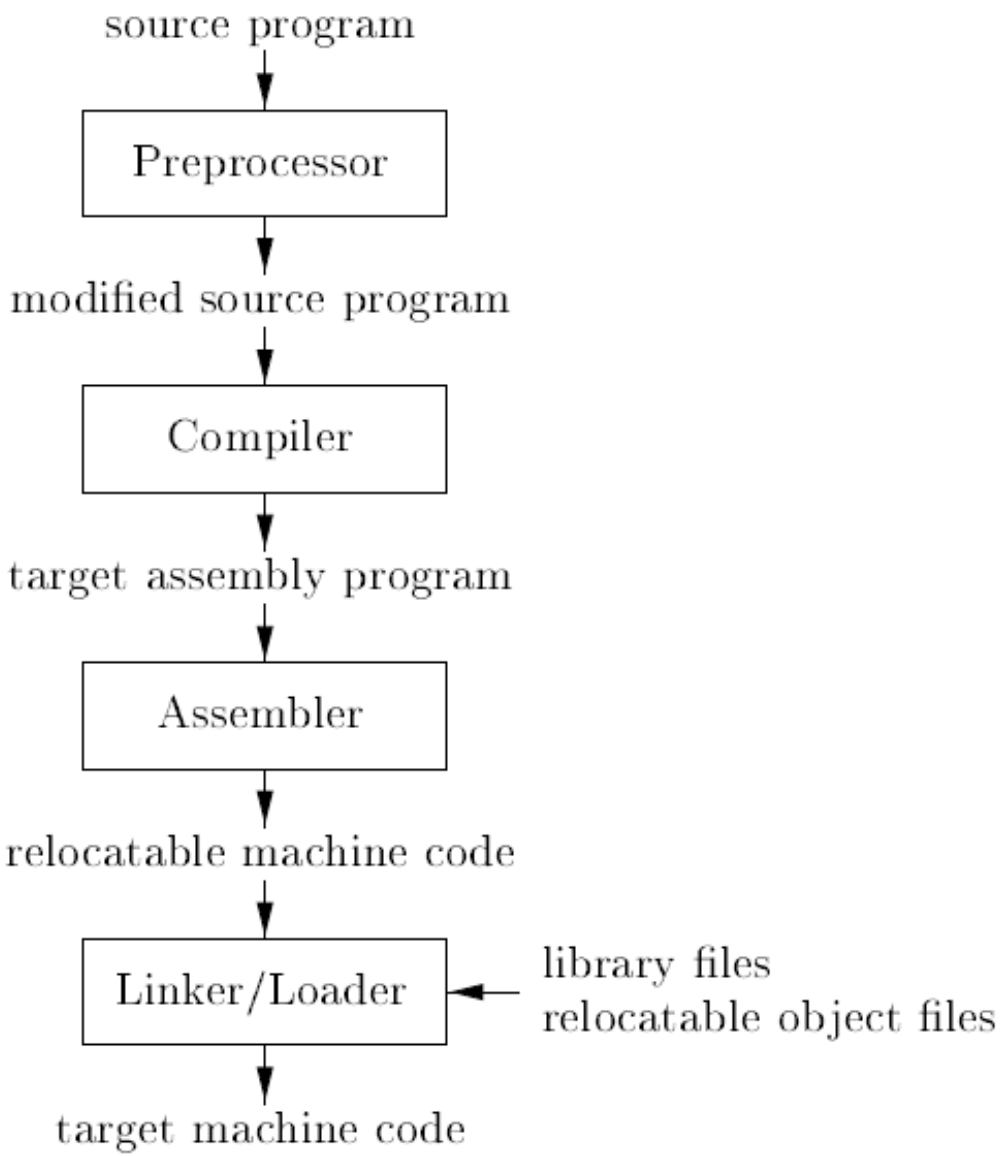
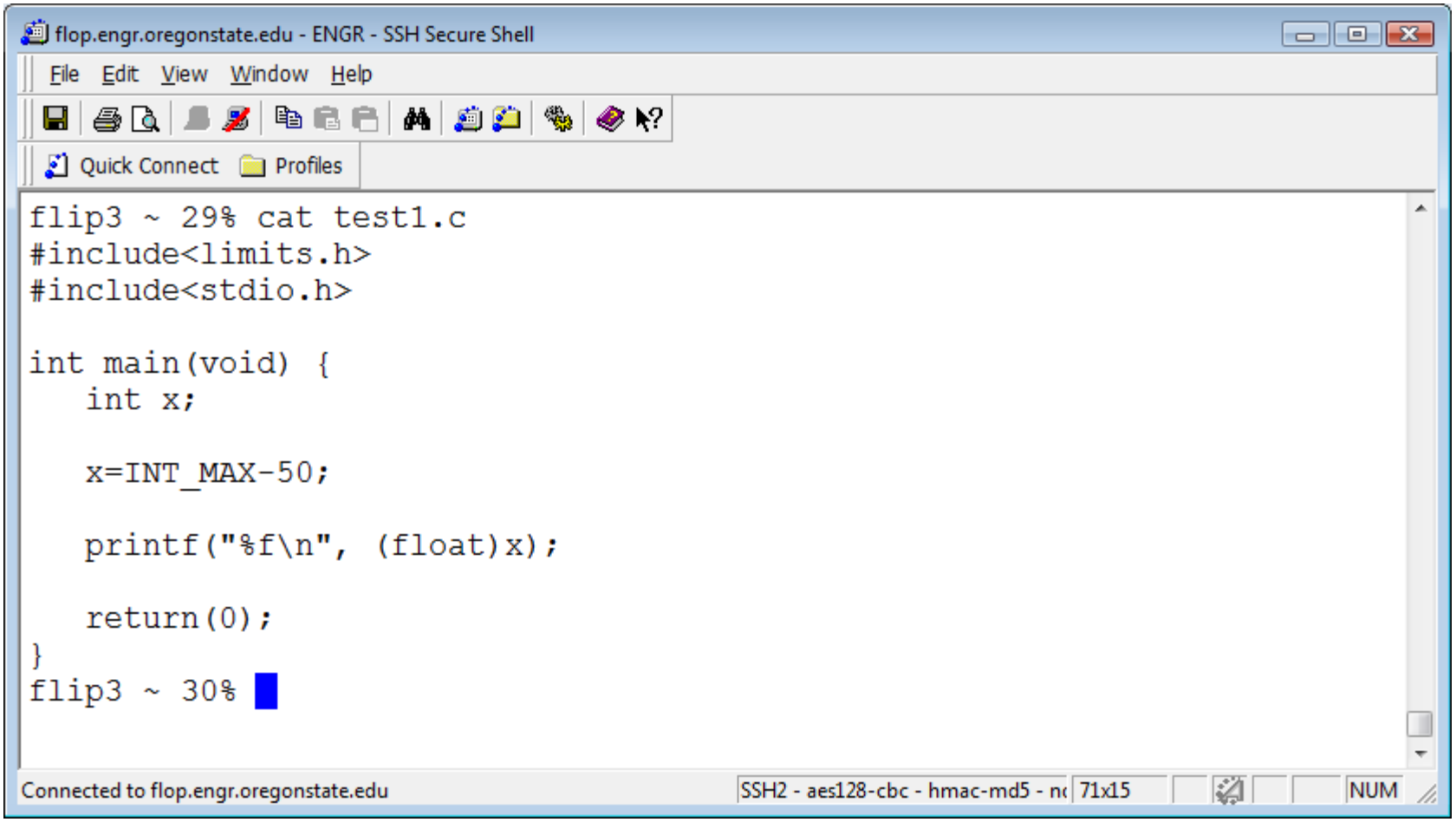
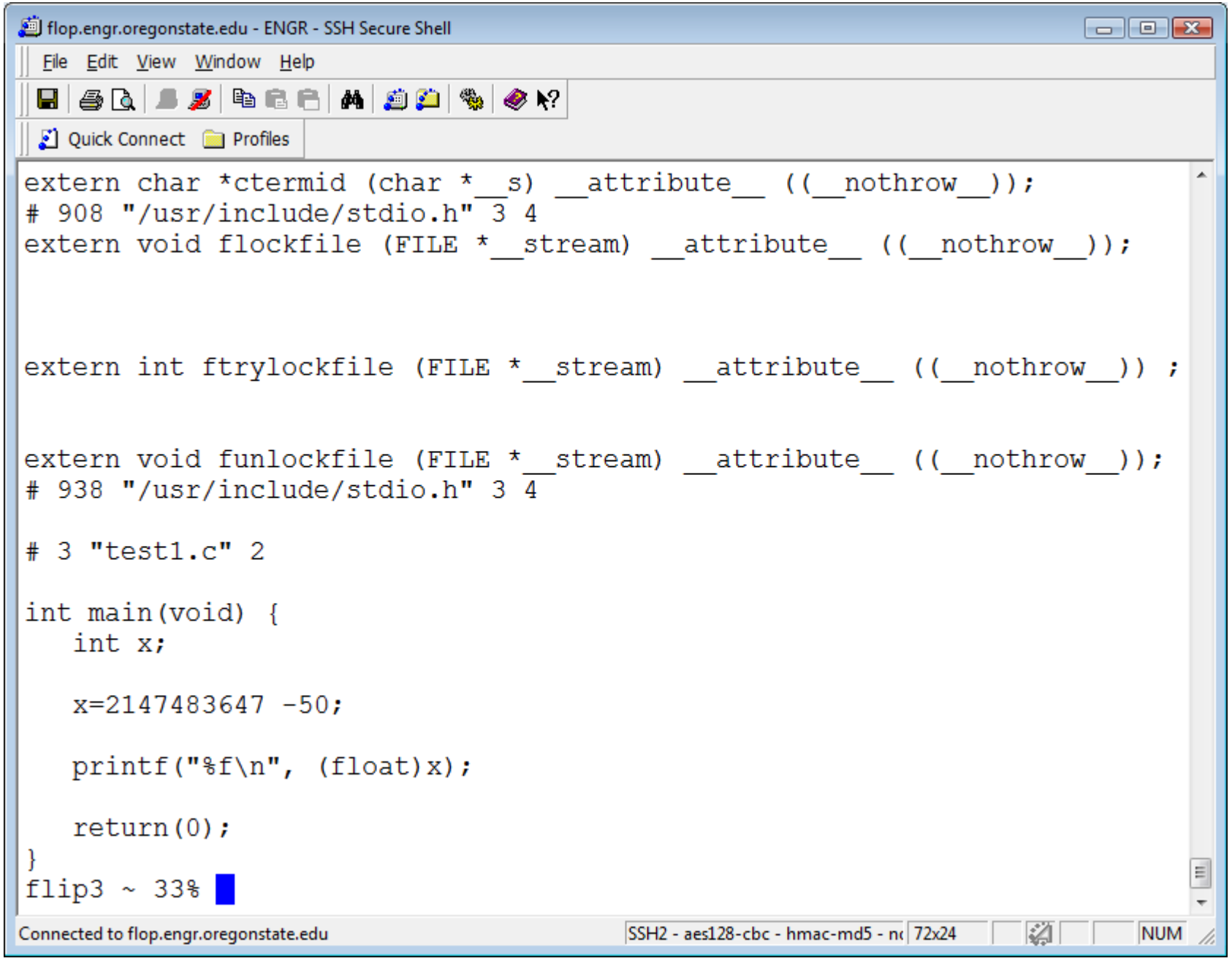
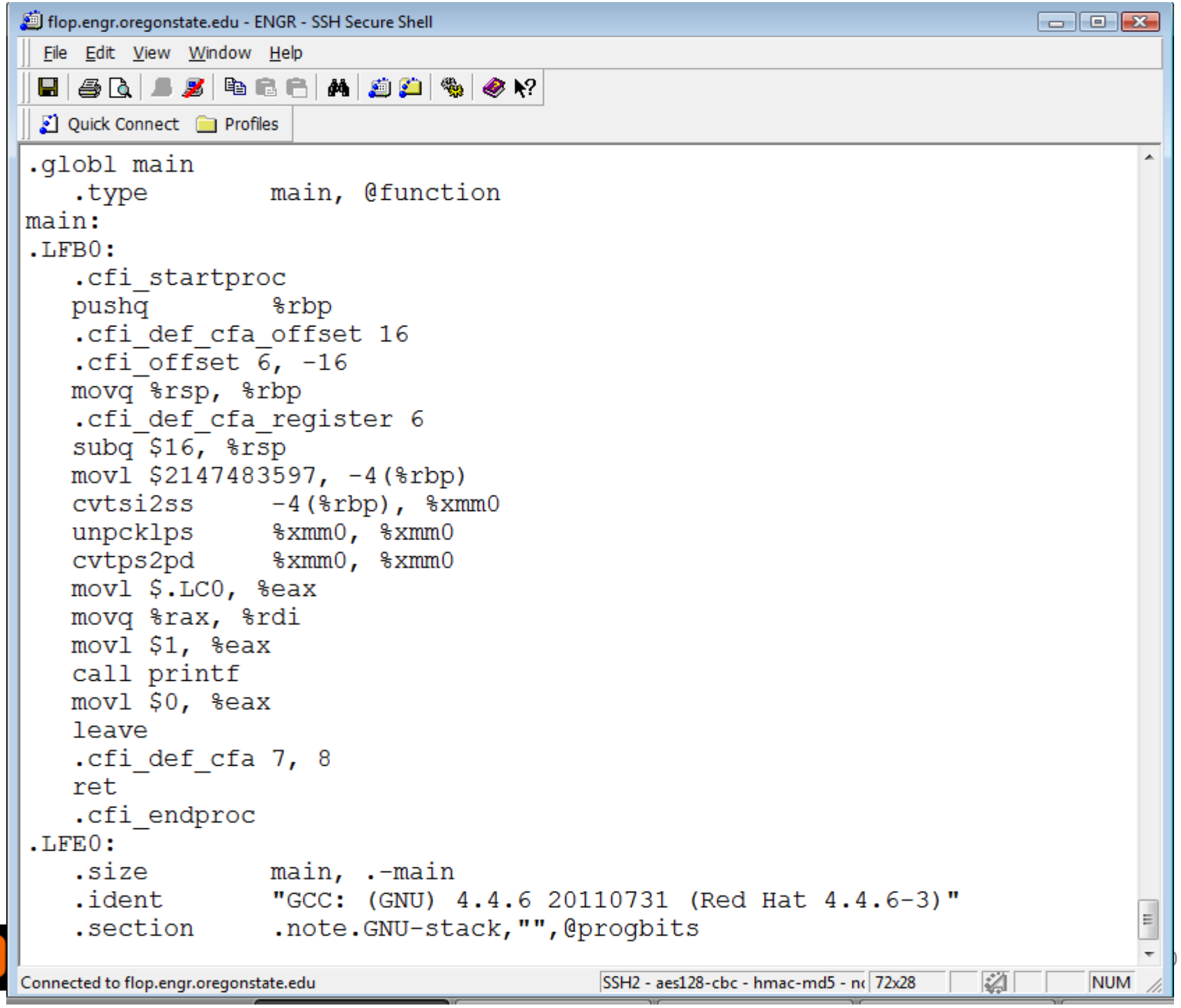


Figure 1.5: A language-processing system


flop.engr.oregonstate.edu - ENGR - SSH Secure Shell
File Edit View Window Help
Quick Connect Profiles
flip3 ~ 29% cat test1.c
#include<limits.h>
#include<stdio.h>
int main(void) {
int x;
x=INT_MAX-50;
printf("%f\n", (float)x);
return(0);
}
flip3 ~ 30%
Connected to flop.engr.oregonstate.edu
SSH2 - aes128-cbc - hmac-md5 - n
71x15
NUM



OSU Oregon State University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File Edit View Window Help
Quick Connect Profiles
.globl main
.type main, @function
main:
.LFB0:
.cfi_startproc
pushq %rbp
.cfi_def_cfa_offset 16
.cfi_offset 6, -16
movq %rsp, %rbp
.cfi_def_cfa_register 6
subq $16, %rsp
movl $2147483597, -4(%rbp)
cvtsi2ss -4(%rbp), %xmm0
unpcklps %xmm0, %xmm0
cvtps2pd %xmm0, %xmm0
movl $.LC0, %eax
movq %rax, %rdi
movl $1, %eax
call printf
movl $0, %eax
leave
.cfi_def_cfa 7, 8
ret
.cfi_endproc
.LFE0:
.size main, .-main
.ident "GCC: (GNU) 4.4.6 20110731 (Red Hat 4.4.6-3)"
.section .note.GNU-stack,"",@progbits
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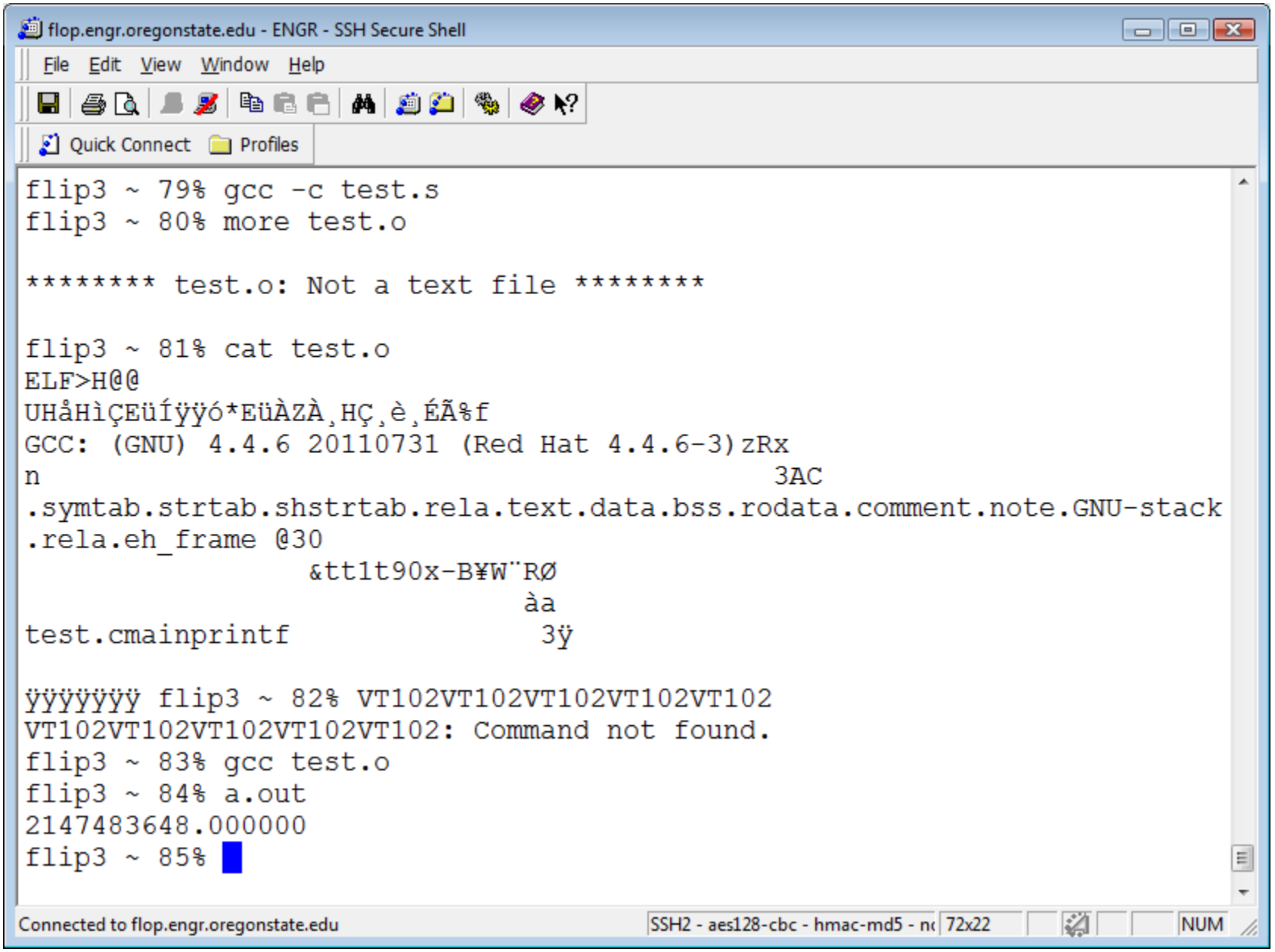
SSH2 - aes128-cbc - hmac-md5 - n
72x28
NUM


flop.engr.oregonstate.edu - ENGR - SSH Secure Shell
File Edit View Window Help
Quick Connect Profiles
flip3 ~ 79% gcc -c test.s
flip3 ~ 80% more test.o
******** test.o: Not a text file ********
flip3 ~ 81% cat test.o
ELF>H@@
UHåHìÇEüÍÿÿó*EüÀZÀ¸HÇ¸è¸ÉÃ%f
GCC: (GNU) 4.4.6 20110731 (Red Hat 4.4.6-3)zRx
n 3AC
.symtab.strtab.shstrtab.rela.text.data.bss.rodata.comment.note.GNU-stack
.rela.eh_frame @30
&tt1t90x-B¥W¨RØ
àa
test.cmainprintf 3ÿ
ÿÿÿÿÿÿÿÿ flip3 ~ 82% VT102VT102VT102VT102VT102
VT102VT102VT102VT102VT102: Command not found.
flip3 ~ 83% gcc test.o
flip3 ~ 84% a.out
2147483648.000000
flip3 ~ 85%
Connected to flop.engr.oregonstate.edu
SSH2 - aes128-cbc - hmac-md5 - n
72x22
NUM

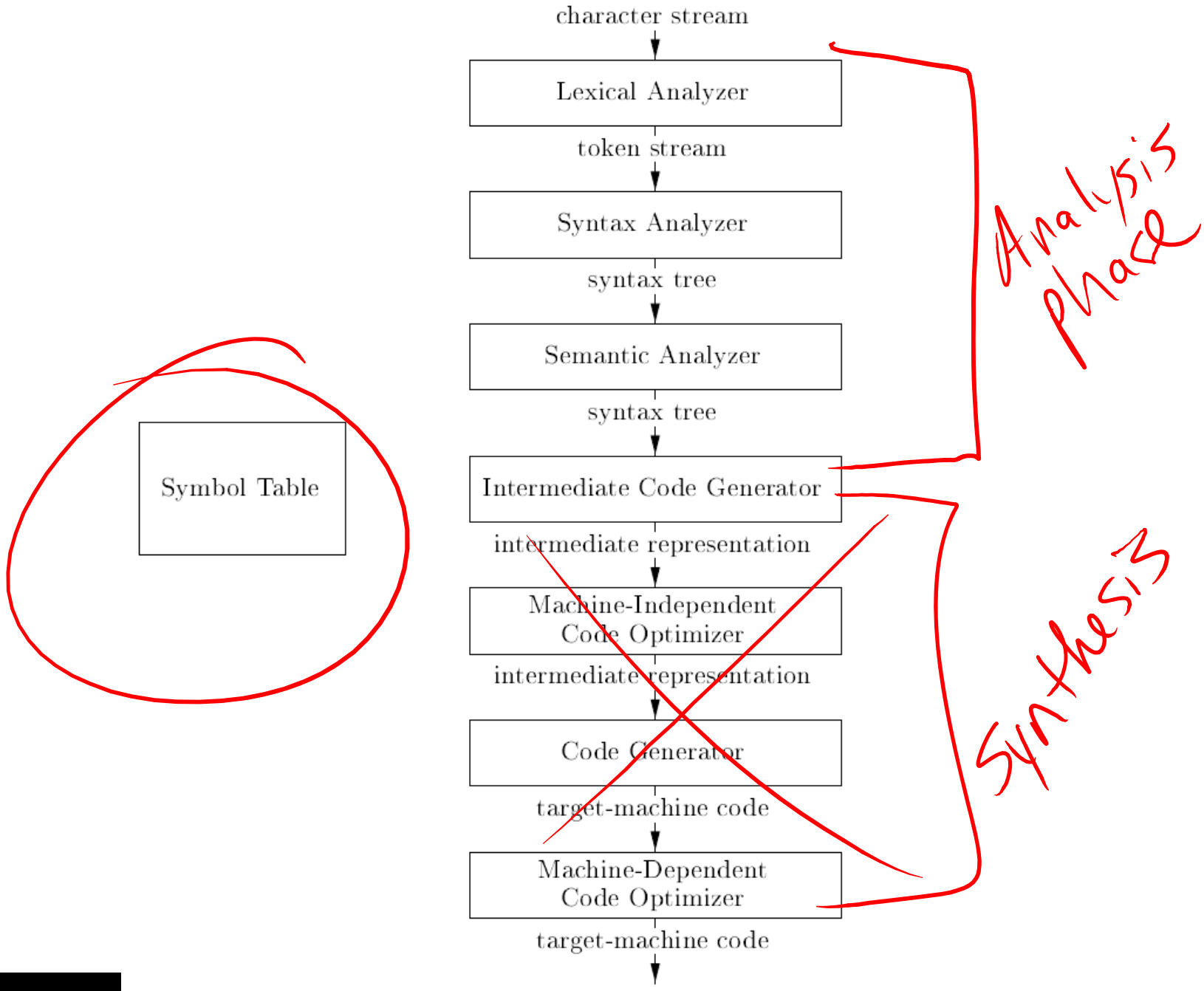


Figure 1.6: Phases of a compiler

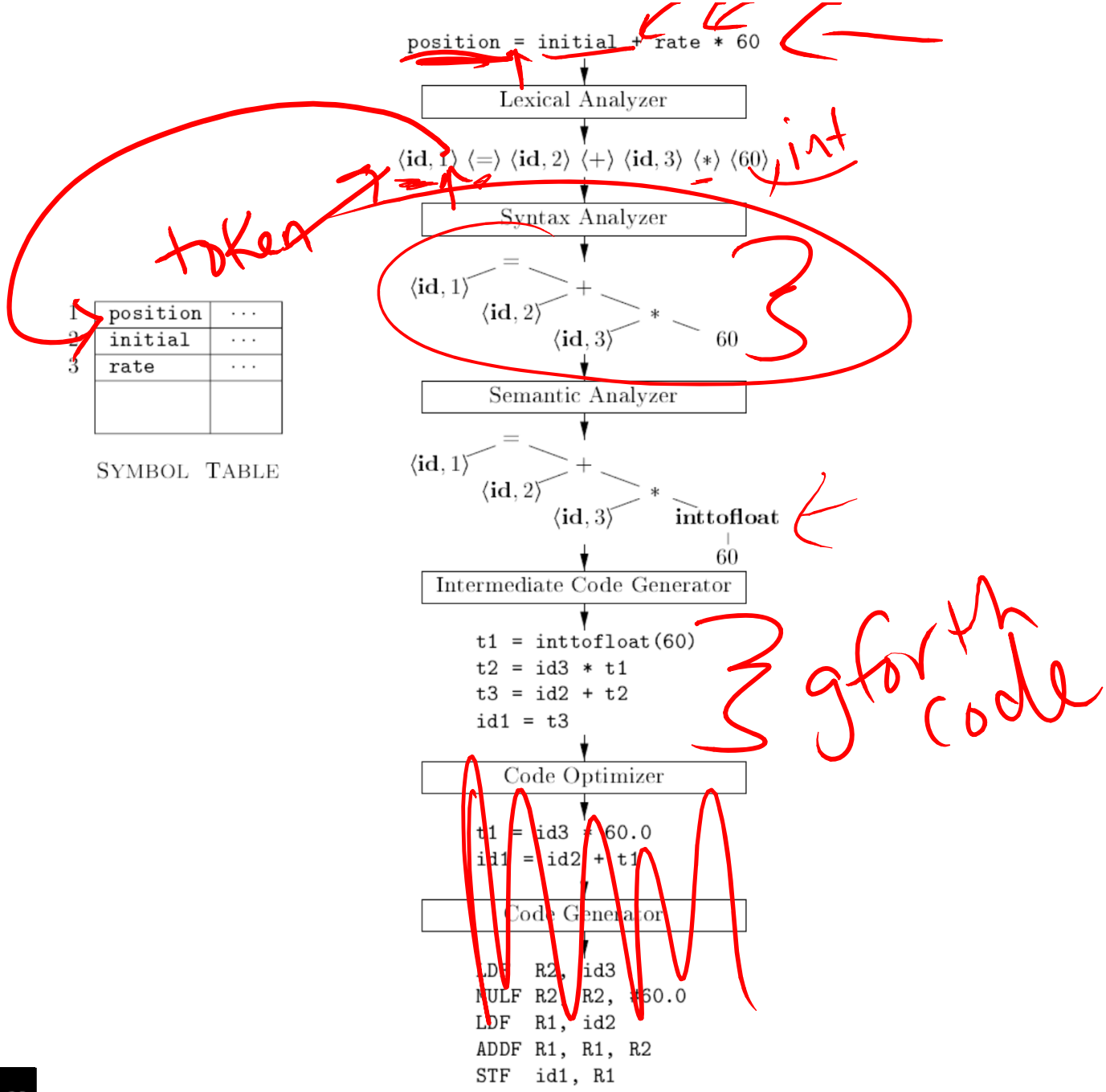


Figure 1.7: Translation of an assignment statement

Compiler-Construction Tools

- Generators for these phases
  - Scanner, parser, syntax-directed, code-gens, etc.
- We won't cover these

Language Basics

- Environments and States
- Block Structure
- Explicit Access Control
- Dynamic Scope
- Parameter Passing Mechanisms
- Aliasing

Environments and States

- x=y+1

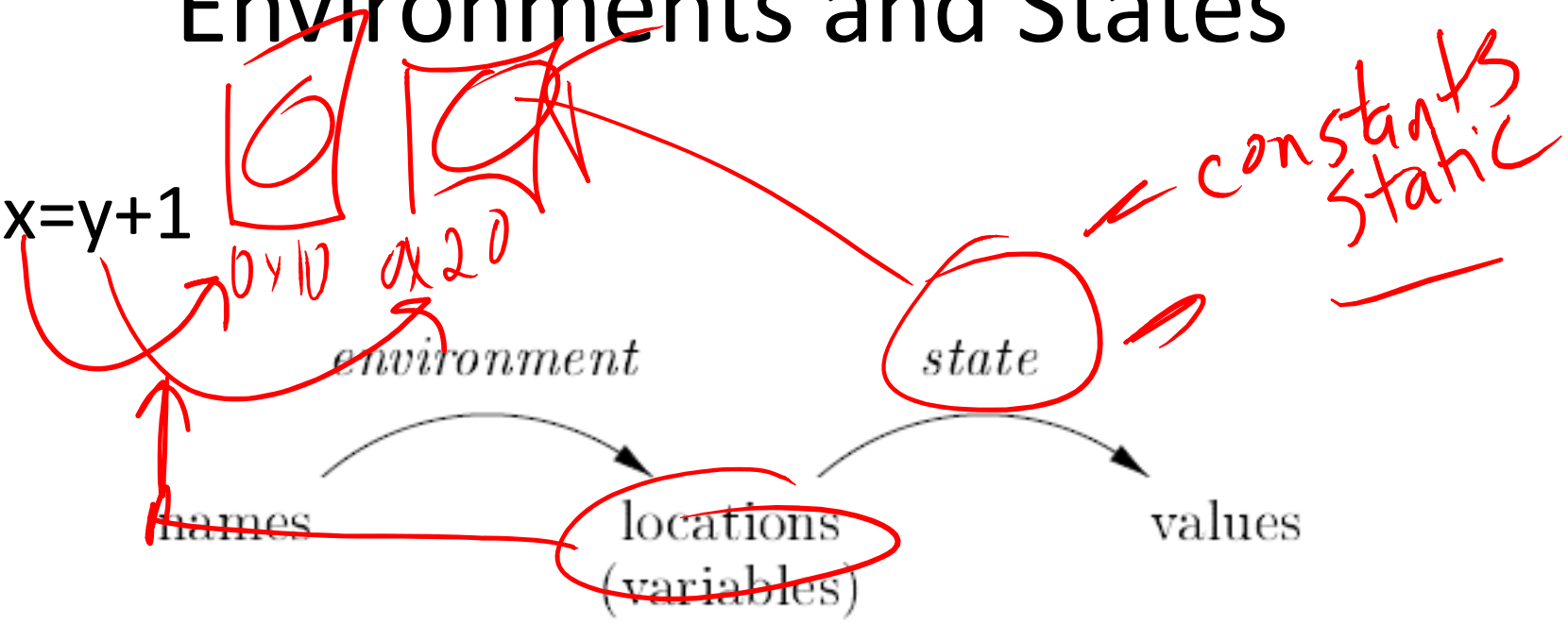
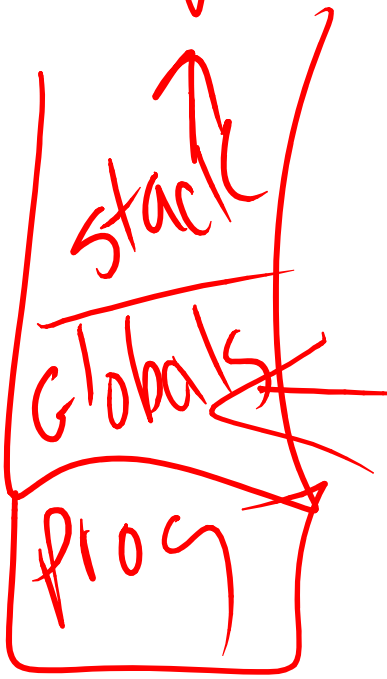


Figure 1.8: Two-stage mapping from names to values

Static vs. Dynamic Binding

```
...
int i;                          /* global i        */
...
void f(···) {
      int i;                    /* local i         */
      ...
      i = 3;                    /* use of local i  */
      ...
}
...
      x = i + 1;                /* use of global i */
```

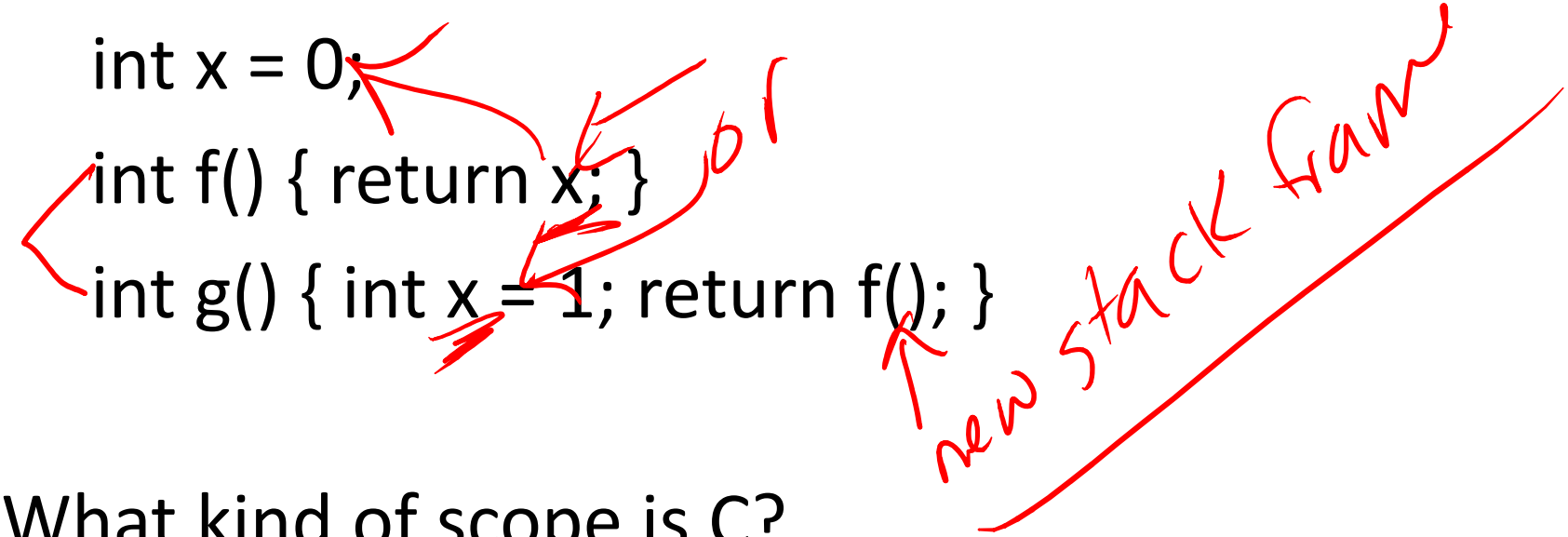
Figure 1.9: Two declarations of the name i



Static vs. Dynamic Scope

- What is static vs. dynamic scope?

```
int x = 0;
int f() { return x; }
int g() { int x = 1; return f(); }
```



- What kind of scope is C?

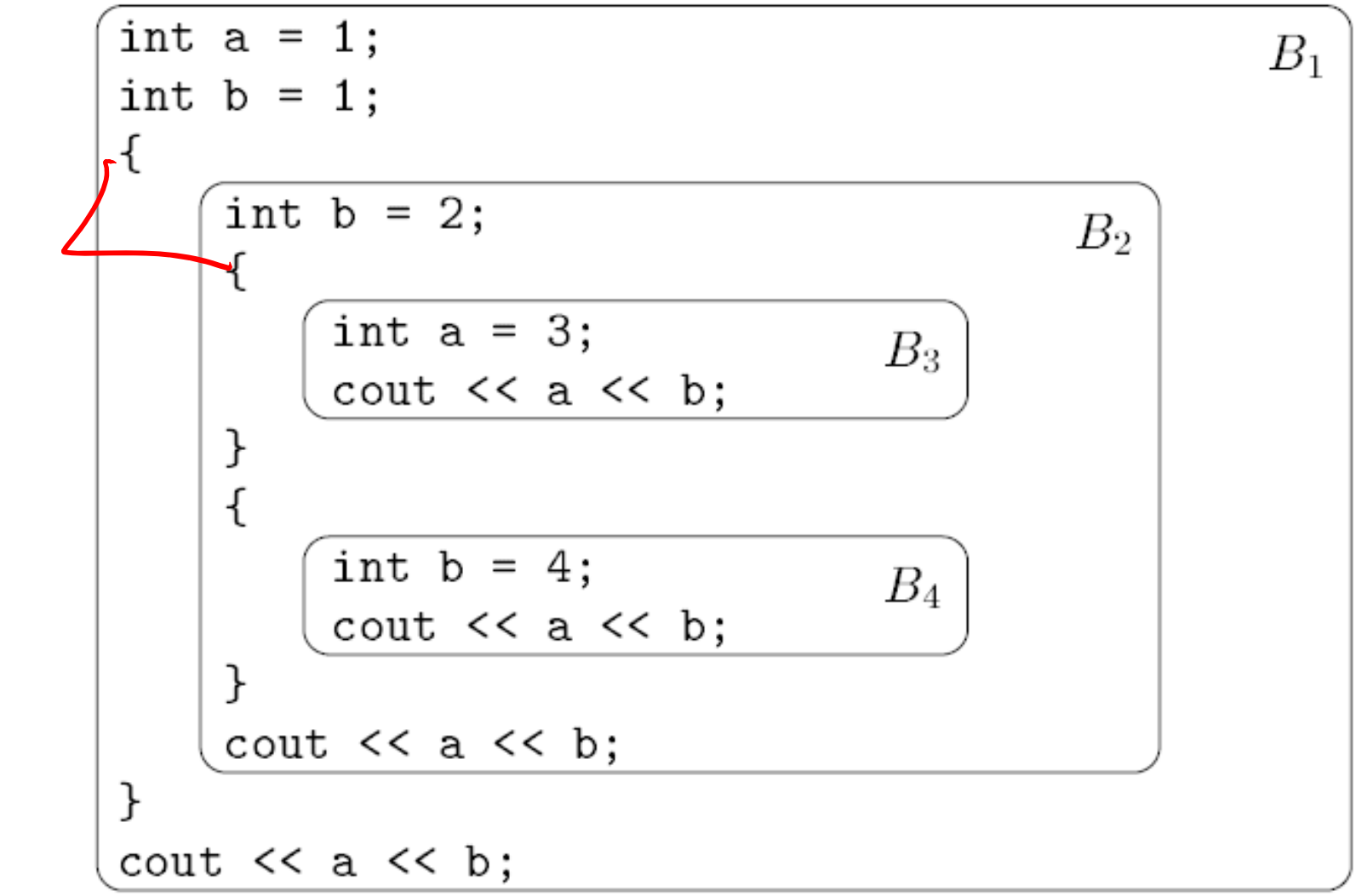


Figure 1.10: Blocks in a C++ program

Dynamic Scope Example

```
#define a (x+1)
int x = 2;
void b() { int x = 1; printf("%d\n", a); }
void c() { printf("%d\n", a); }
void main() { b(); c(); }
```

Figure 1.12: A macro whose names must be scoped dynamically

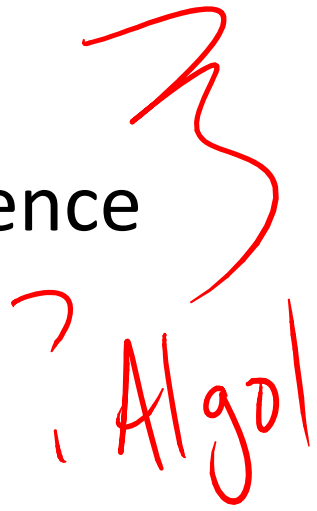
- What is another example of dynamic scope?

Explicit Access Control

- Public
- Private
- Protected

Parameter Passing Mechanisms

- Pass by Value
- Pass by Reference
- Pass by Name



Aliasing

- What is this?
- Where do we see this?
- Ex.

```
public class test {
   public static void main (String[] args) {
      int a[]=new int[1];
      q(a,a);
   }
   public static void q(int x[], int y[]) {
      y[0]=2;
      x[0]=23;
      System.out.println(y[0]);
   }
}
```

Your First Milestone

- Learn a new language
- Get a Makefile working
- Write a Milestone report
- Review Milestone 1…