Welcome to CS 536:
Introduction to Programming Languages and Compilers!

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Course websites:

`canvas.wisc.edu`

`www.piazza.com/wisc/spring2024/compsci536`

`pages.cs.wisc.edu/~hasti/cs536`

About the course

We will study compilers

We will understand how they work

We will build a full compiler

Course mechanics

Exams (60%)
- Midterm 1 (18%): Thursday, February 29, 7:30 – 9 pm
- Midterm 2 (16%): Thursday, March 21, 7:30 – 9 pm
- Final (26%): Sunday, May 5, 2:45 – 4:45 pm

Programming Assignments (40%)
- 6 programs: 5% + 7% + 7% + 7% + 7%+ 7%

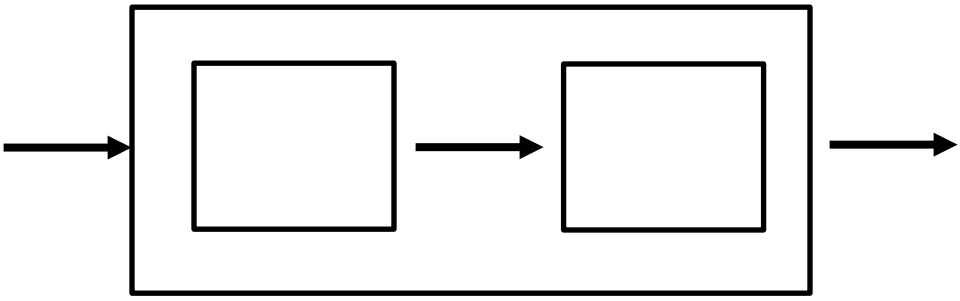
Homework Assignments
- 8 short homeworks (optional, not graded)

What is a compiler?

A compiler is

- recognizer of language S
- a translator from S to T
- a program in language H

Front end vs back end

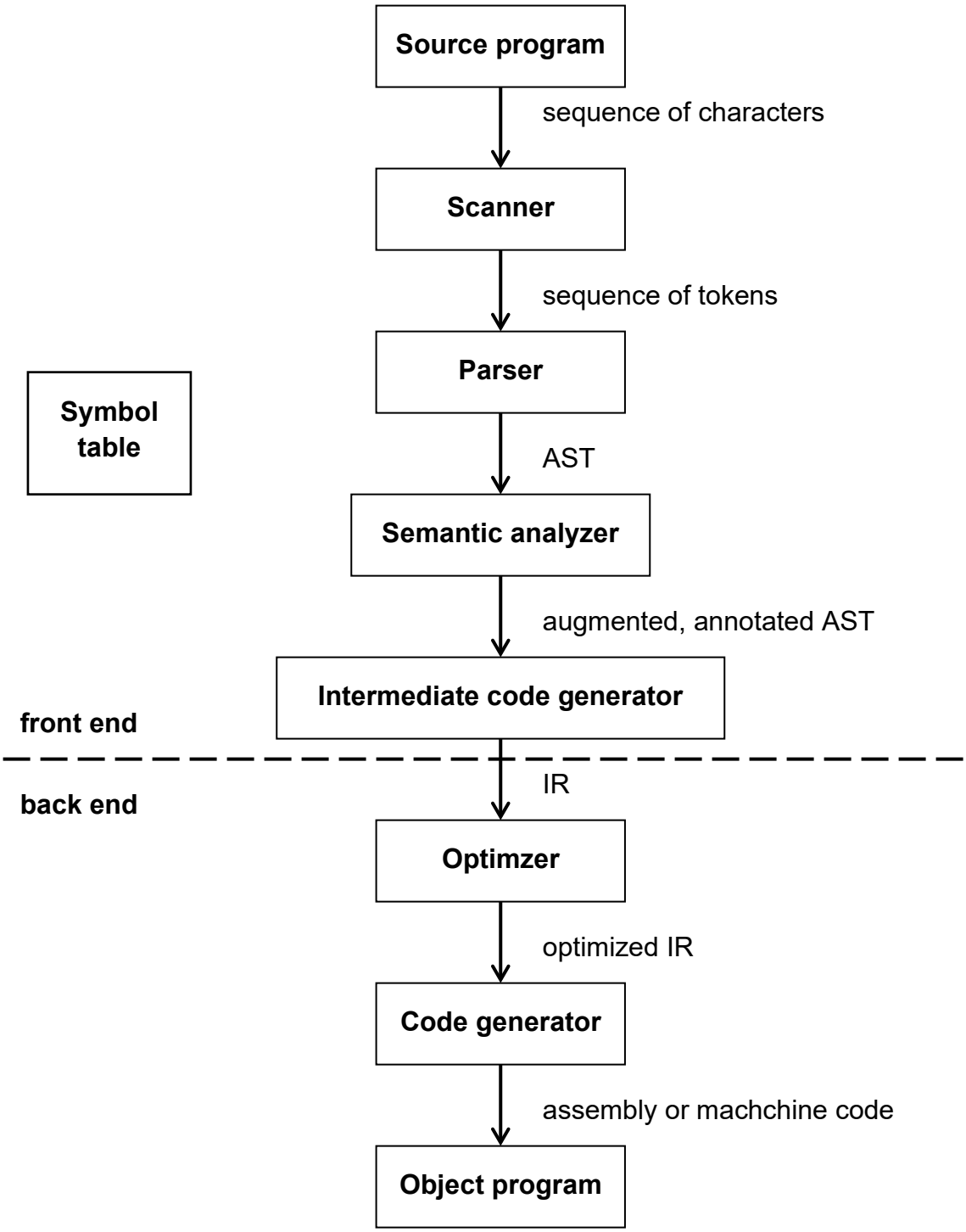


front end = understand source code S; map S to IR

IR = intermediate representation

back end = map IR to T

Overview of typical compiler



Scanner

Input: characters from source program

Output: sequence of tokens

Actions:

- group characters into lexemes (tokens)
- identify and ignore whitespace, comments, etc.

What errors can it catch?

- bad characters
- unterminated strings
- integer literals that are too large

Parser

Input: sequence of tokens from the scanner

Output: AST (abstract syntax tree)

Actions:

- group tokens into sentences

What errors can it catch?

- syntax errors
- (possibly) *static semantic* errors

Semantic analyzer

Input: AST

Output: annotated AST

Actions: does more static semantic checks

- Name analysis
- Type checking

Intermediate code generator

Input: annotated AST

Output: intermediate representation (IR)

Example

```
a = 2 * b + abs(-71);
```

Scanner produces tokens:

AST (from parser)

Symbol table

3-address code

Optimizer

Input: IR

Output: optimized IR

Actions: improve code

- make it run faster, make it smaller
- several passes: local and global optimization
- more time spent in compilation; less time in execution

Code generator

Input: IR from optimizer

Output: target code

Symbol Table

Compiler keeps track of names in

- semantic analyzer
- code generation
- optimizer

P1 : implement symbol table

Block-structured language

- nested visibility of names
- easy to tell which def of a name applies
- lifetime of data is bound to scope

Example: (from C)

```
int x, y;

void A() {
   double x, z;
   C(x, y, z);
}

void B(){
   C(x, y, z);
}
```