CS6660 - Compiler Design

Introduction

Course Outline

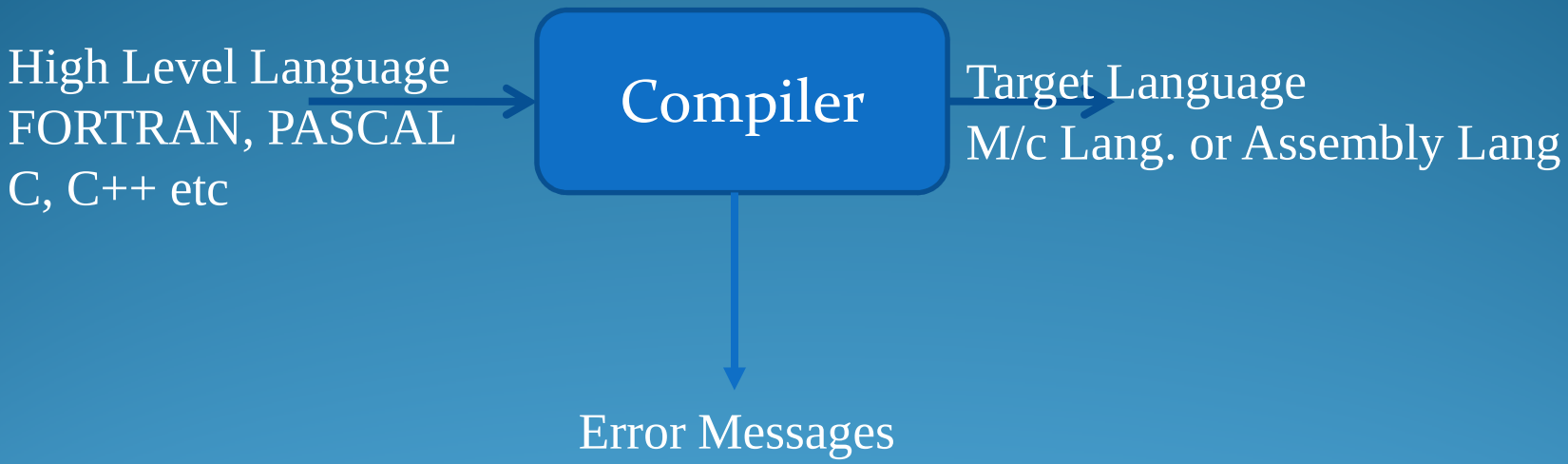
- Introduction to Compiling
- Lexical Analysis
- Syntax Analysis
  - Context Free Grammars
  - Top-Down Parsing, LL Parsing
  - Bottom-Up Parsing, LR Parsing
- Syntax-Directed Translation
- Run-Time Organization
- Intermediate Code Generation
- Code Optimization
- Code Generation

Introduction to Compiling

- **Translators**

Introduction to Compiling

- **Compiler**



Introduction to Compiling

- **Assembler**

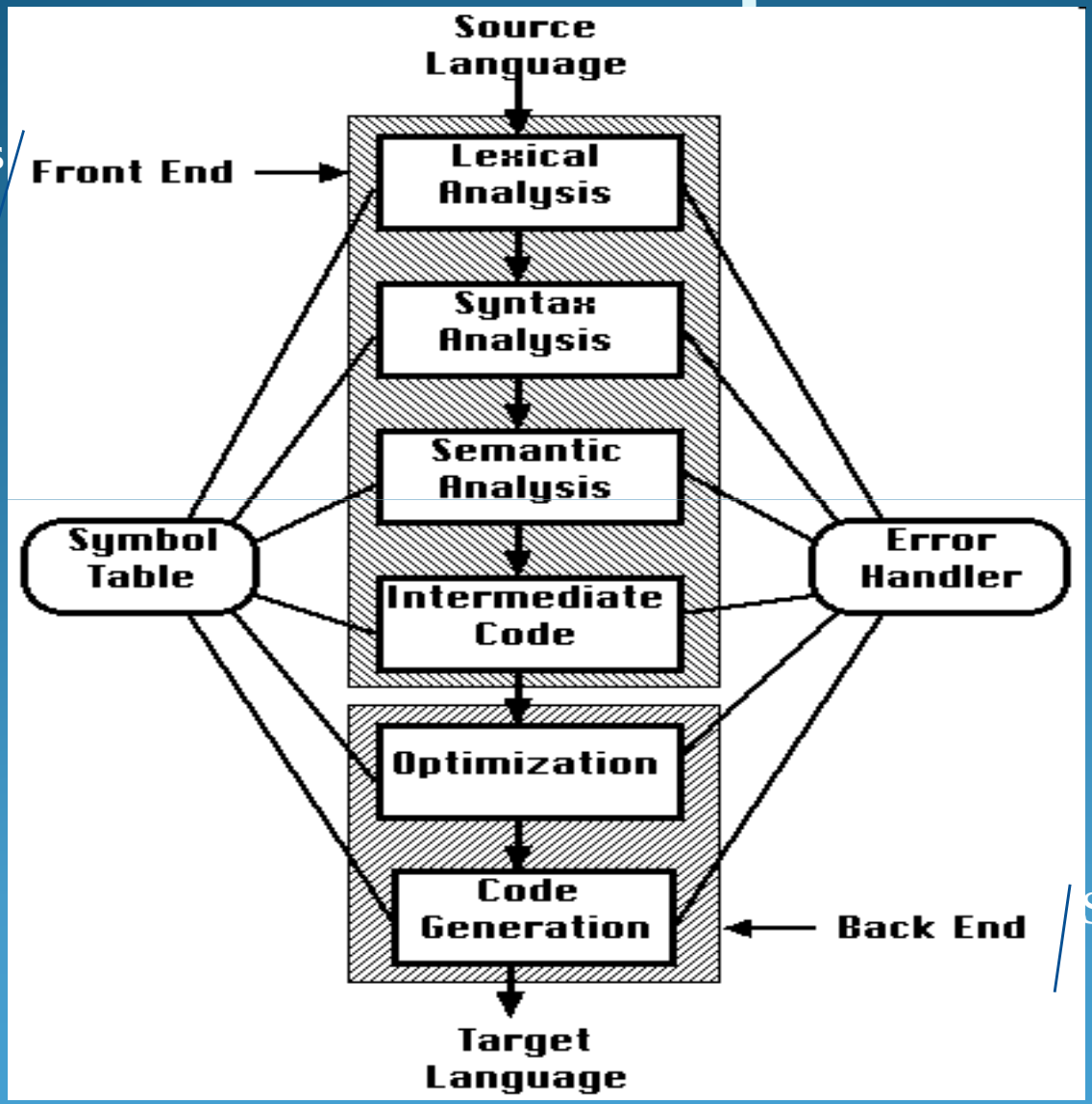
Introduction to Compiling

- **Preprocessor**

Introduction to Compiling

- Interpreter
  - Input → Intermediate code
  - Instead of output, performs operations implied by the source program.

Phases of a Compiler



Analysis Phase

Synthesis Phase

Major parts of Compiler

- **Analysis Phase** and **Synthesis Phase**
- **Analysis phase**
  - an intermediate representation is created from the given source program.
  - Lexical Analyzer, Syntax Analyzer and Semantic Analyzer are the parts of this phase.
- **Synthesis phase**
  - the equivalent target program is created from this intermediate representation.
  - Intermediate Code Generator, Code Generator, and Code Optimizer are the parts of this phase.

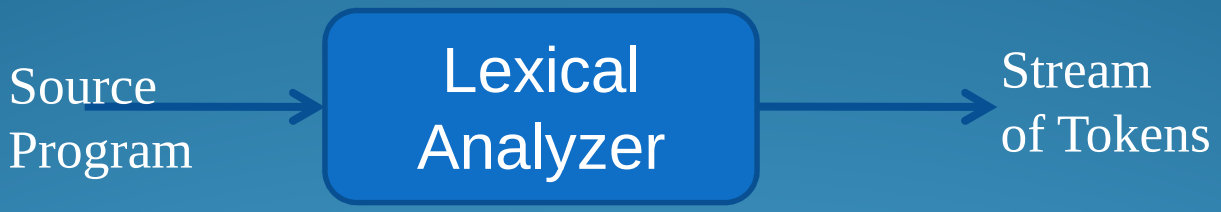
Applications

- Techniques used in a **lexical analyzer** can be used in **text editors, information retrieval system, and pattern recognition programs.**
- Parser → query processing system such as SQL.
- Many software having a complex front-end may need techniques used in compiler design.
- Most of the techniques used in compiler design can be used in Natural Language Processing (NLP) systems.

Overview of Compilation

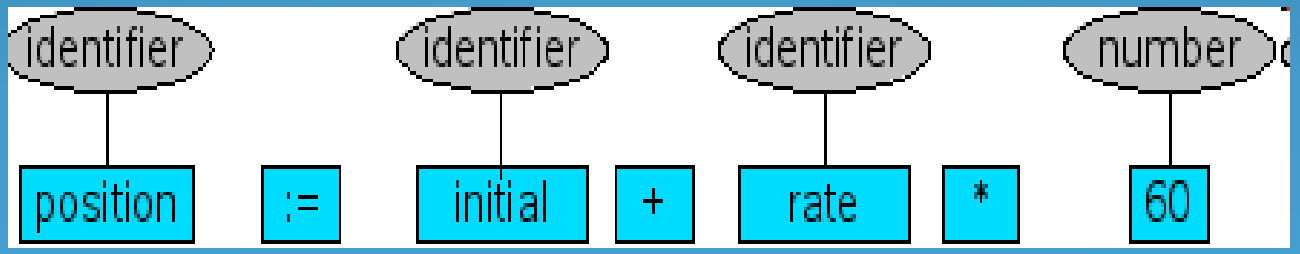
Lexical Analyzer

- Reads Characters from left to right
- Tokens → identifiers, keywords, operators, punctuation symbols, multi character operators



Lexical Analyzer Cont…

- position := initial + rate * 60
  - The identifier position.
  - The assignment symbol :=.
  - The identifier initial.
  - The plus sign.
  - The identifier rate.
  - The multiplication sign.
  - The number 60.



Syntax Analyzer

- Parser also know as Hierarchical analysis

- Performs 2 functions
  - Checks the token if they occur in patterns specified by the source language
  - Construct a tree like structure that can be used by the subsequent phases

Syntax Analyzer Cont…

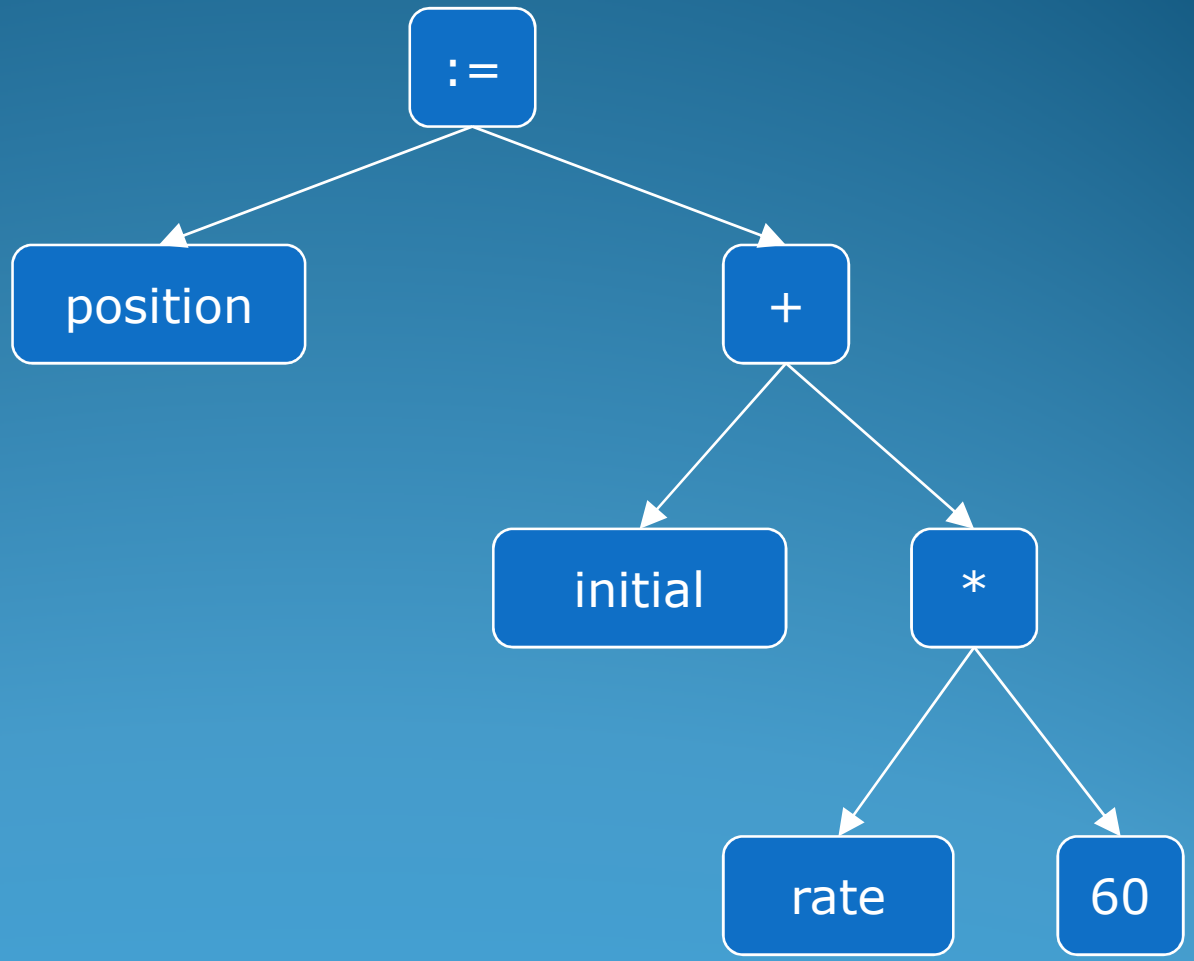
- The hierarchical structure of programs is usually described by recursive rules like the following ones that describe expressions:

1. Any *Identifier* is an *expression*.
2. Any *Number* is an *expression*.
3. If *Expression*1 and *Expression*2 are expressions, then so are:
   a. *Expression*1+*Expression*2
   b. *Expression*1***Expression*2
   c. *(Expression*1)
4. If *Identifier*1 is an identifier and *Expression*2 is an expression, then *Identifier*1 := *Expression*2 is a statement.
5. If *Expression*1 is an expression and *Statement*2 is a statement, then
   a. while (*Expression*1) do*Statement*2
   b. if (*Expression*1) then*Statement*2 are statements.

Syntax Analyzer Cont…

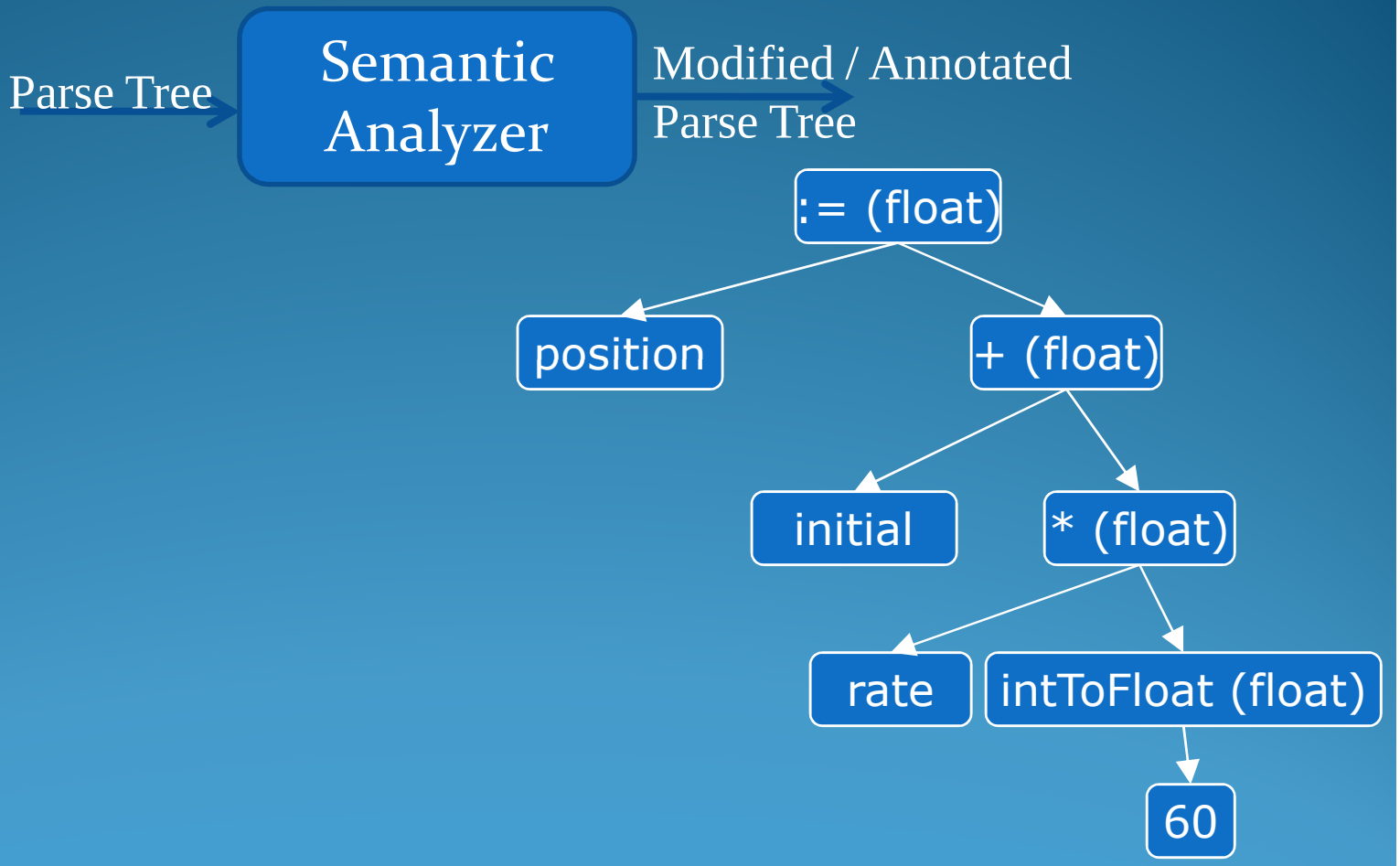
- According to rule (1)
- position, initial and rate are expressions.
- Rule (2) states that 60 in an expression.
- Rule (3) says that rate * 60 is an expression
- Finally Rule (4) says that initial + rate * 60 is an expression.

Syntax Analyzer Cont…



Semantic Analyzer

- Checks for (more) "static semantic" errors



Intermediate Code Generator

- Variety of Intermediate Representations

temp1 := inttofloat(60)
temp2 := rate * temp1
temp3 := initial + temp2
position := temp3

Intermediate Code Generator

- Properties of 3 Address Code
  - Atmost one operator other than assignment operator.
  - Compiler must generate a temporary name to hold the value computed by each instruction.
  - Some 3 address instruction can have less than 3 operands.

Code Optimizer

- Tries to improve code to
  - Run faster
  - Be smaller
  - Consume less energy

temp1:=id3*60.0

id1:=id2+temp1

Code Generator

MOVF id3,R2

MULF #60.0,R2

MOVF id2,R1

ADDF R2,R1

MOVF R1,id1

Symbol Table

- Keep track of names declared in the program
- Separate level for each scope
- Linear List → Slow but easy to implement
- Hash table → Complex to implement but fast.

Error Handler

- Involves
  - Detection of errors
  - Reporting Errors
  - Recovery of Errors.