COSE312: Compilers

Lecture 1 — Overview of Compilers

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2015 Fall

What is Compiler?

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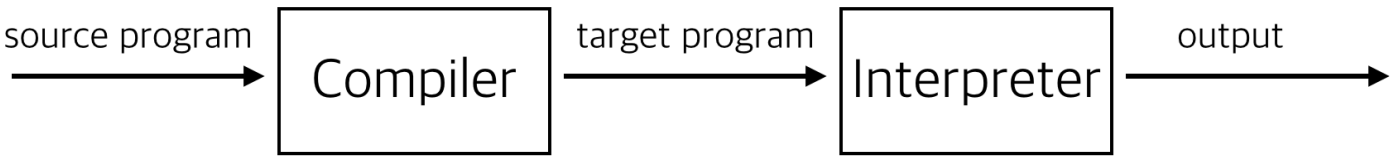
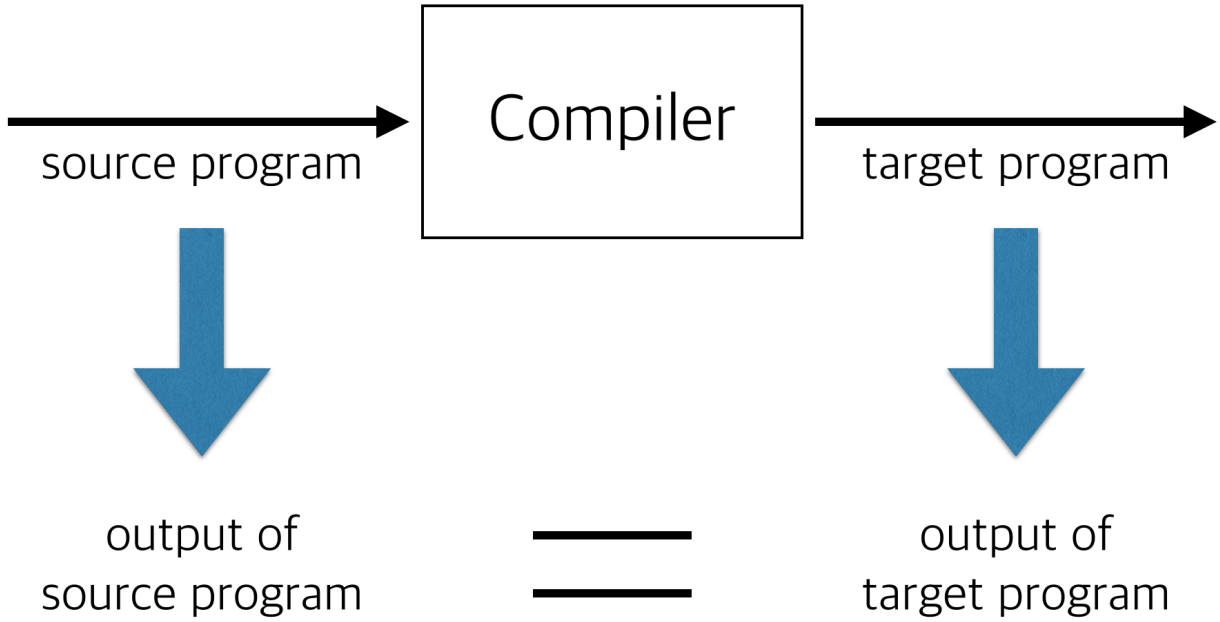
cf) When the target language is not a machine language:

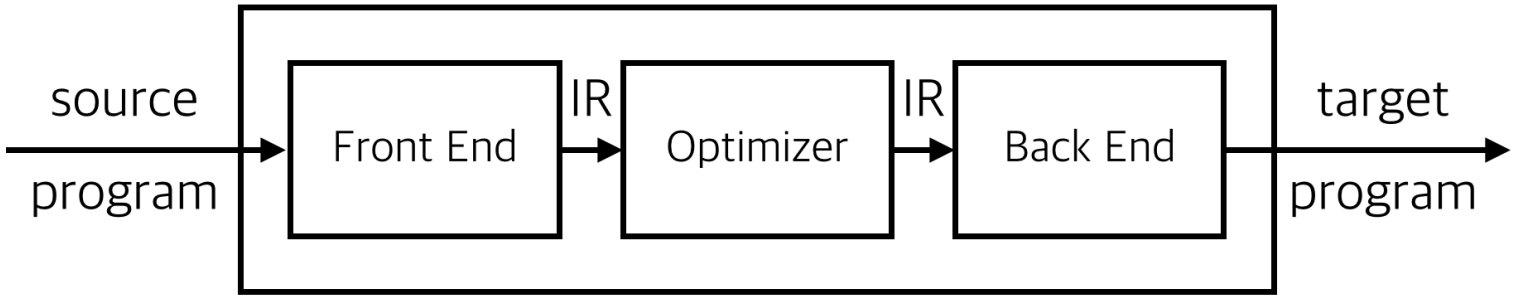


A Fundamental Requirement

The compiler must preserve the meaning of the source program.



Structure of Modern Compilers



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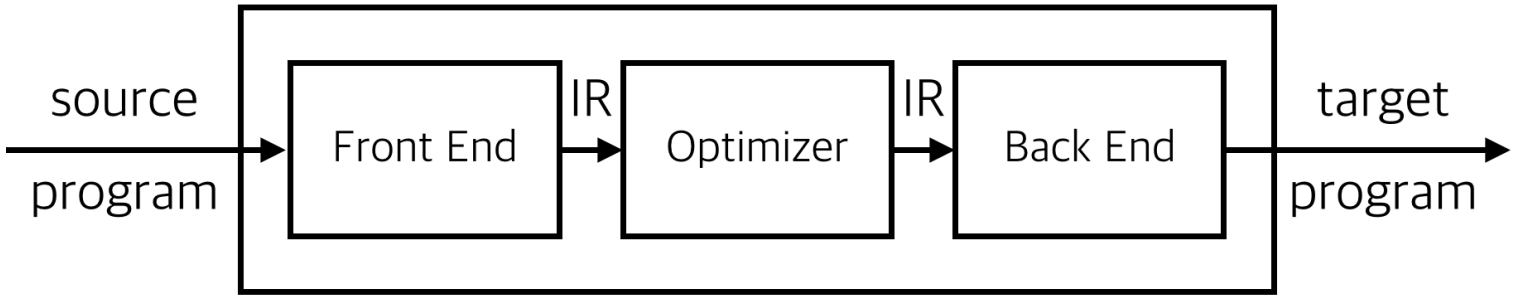
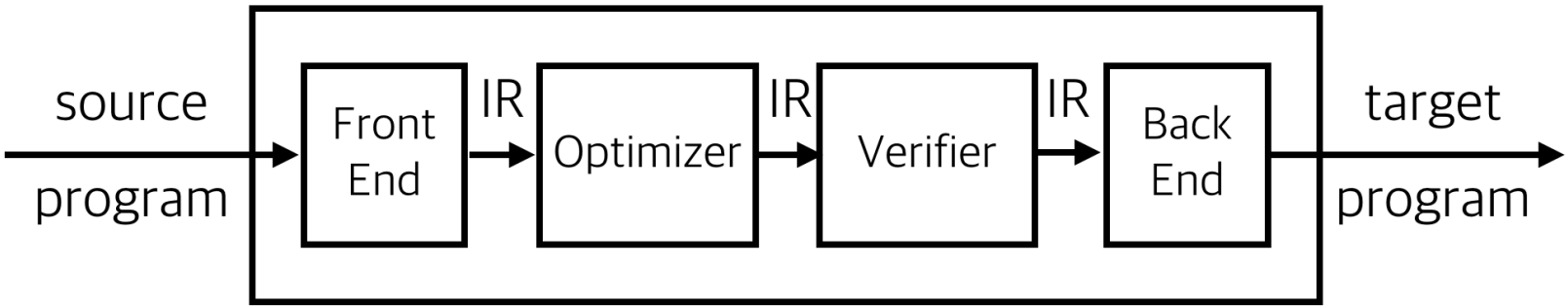
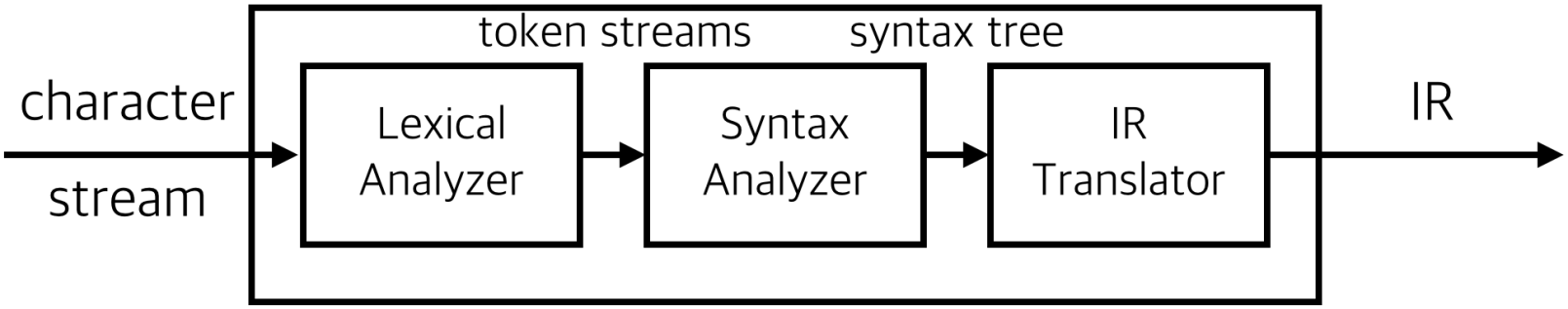


cf) "verifying compilers" (a grand challenge in CS):



Front End


token streams
syntax tree
character
stream
Lexical
Analyzer
Syntax
Analyzer
IR
Translator
IR

Lexical[1] Analyzer (Lexer)

A lexer analyzes the lexical structure of the source program:

[1] of or relating to words or the vocabulary of a language as distinguished from its grammar and construction

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into a sequence of *lexemes*:

"`pos`", "`=`", "`init`", "`+`", "`rate`", "`*`", "`10`"

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into a sequence of *lexemes*:

"`pos`", "`=`", "`init`", "`+`", "`rate`", "`*`", "`10`"

and then produces a *token* sequence:

(ID, `pos`), ASSIGN, (ID, `init`), PLUS, (ID, `rate`), MULT, (NUM,`10`)

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Syntax[2] Analyzer (Parser)

A parser analyzes the grammatical structure of the source program:

[2] the way in which words are put together to form phrases, clauses, or sentences

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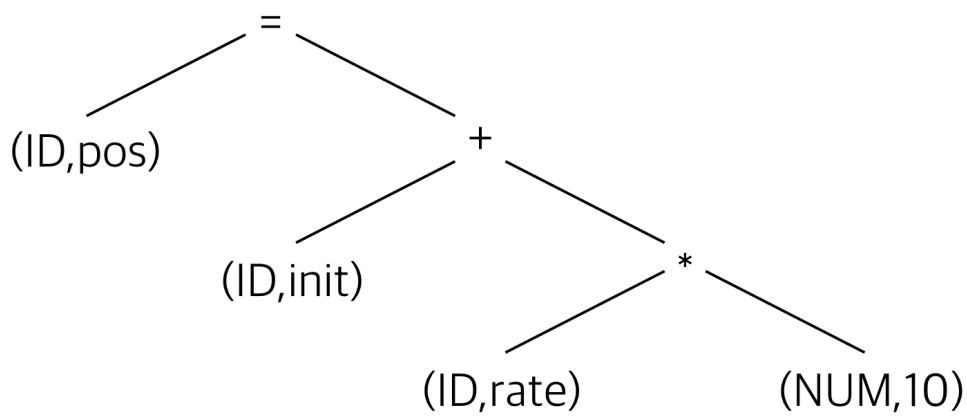
A parser analyzes the grammatical structure of the source program:

ex) the parser transforms the sequence of tokens

(ID, `pos`), =, (ID, `init`), +, (ID, `rate`), *, (NUM,10)

into the syntax tree:



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IR Translator

Intermediate Representation:

- lower-level than the source language
- higher-level than the target language

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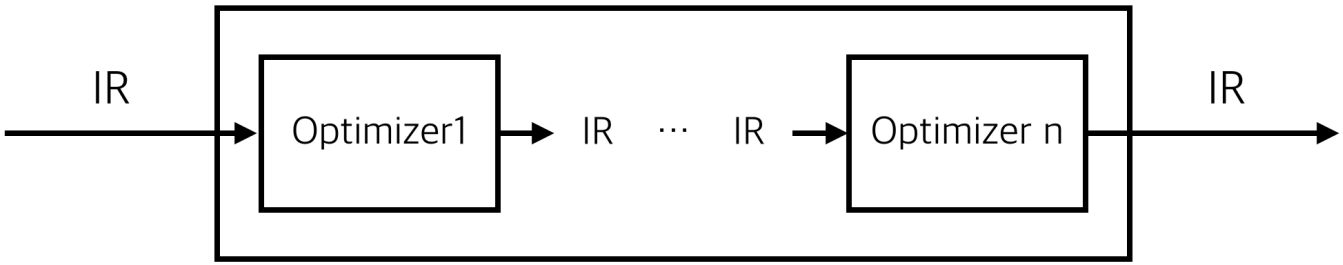
ex) translate the syntax tree into *three-address code*:

```
t1 = 10
t2 = rate * t1
t3 = init + t2
pos = t3
```

Optimizer

Transform IR to have better performance:



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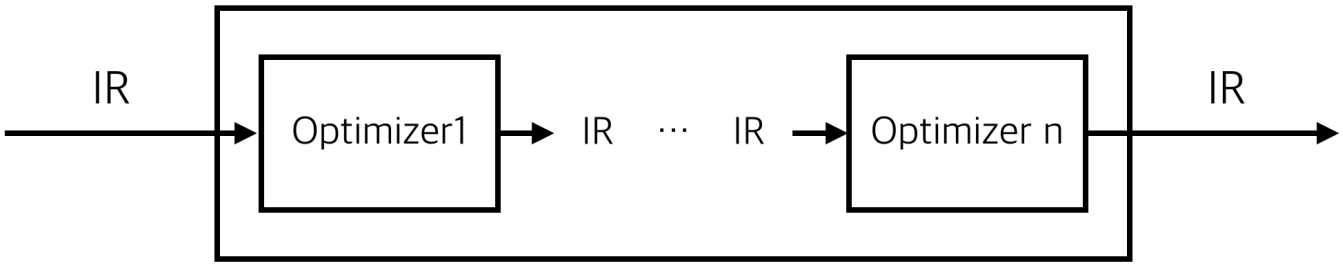

ex)

```
t1 = 10
t2 = rate * t1
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pos = t3
```

original IR

```
t1 = 10
t2 = rate * 10
t3 = init + t2
pos = t3
```

```
t2 = rate * 10
t3 = init + t2
pos = t3
```

```
t2 = rate * 10
pos = init + t2
```

final IR

Back End

Generate the target machine code:

ex) from the IR

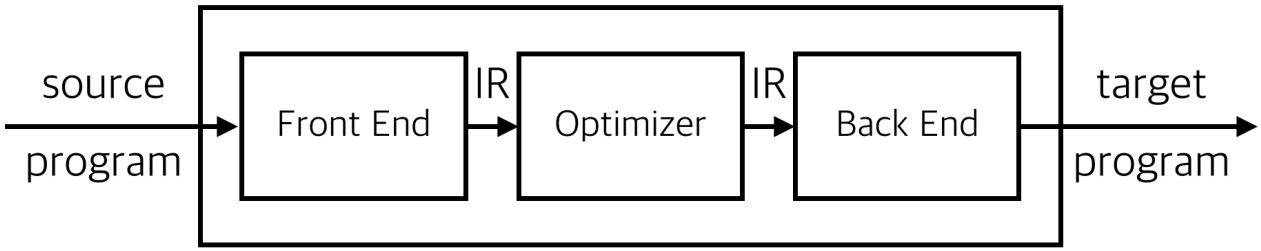
```
t2 = rate * 10
pos = init + t2
```

generate the machine code

```
LOAD  R2, rate
MUL   R2, R2, #10
LOAD  R1, init
ADD   R1, R1, R2
STORE pos, R1
```

Summary

A modern compiler consists of three phases:



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- The optimizer improves the quality of the program.
- The back end generates the target program.

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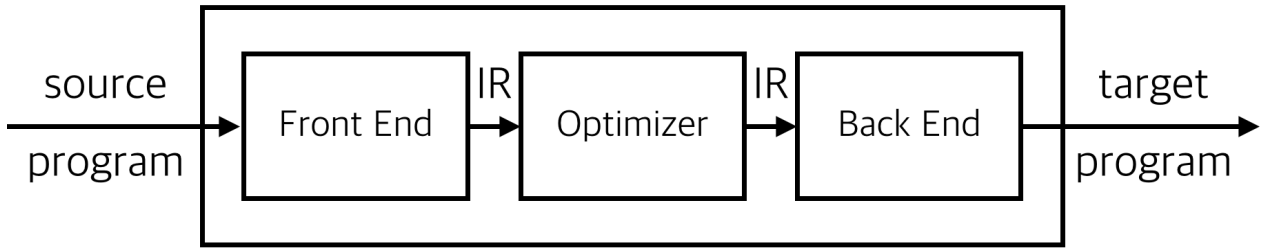

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cf) Remember: