Lecture 6

Syntax Analysis

Awanish Pandey

Department of Computer Science and Engineering
Indian Institute of Technology
Roorkee

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Take aways from the last class

- Extended regular expressions

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- Lexical Analyzer generator

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- Lex file format and compilation steps

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- Working principle of the `lex`
- Correctness check of a string based on `lex` rules
- Interface with other passes

Overview of Syntax Analysis

- Check syntax and construct abstract syntax tree

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- Error reporting and recovery

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- To check whether a variable has been initialized ✗
- These issues will be handled in semantic analysis

Derivation

Does $9 - 5 + 2$ belong to the following grammar?

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\begin{aligned}
\mathit{list} &\rightarrow \mathit{list} + \mathit{digit} \\
&\quad |\mathit{list} - \mathit{digit} \\
&\quad |\mathit{digit} \\
\mathit{digit} &\rightarrow 0|1|2\ldots|9
\end{aligned}
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- Which production rule should I select?

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- An ambiguous grammar is one that produces more than one leftmost/rightmost derivation of a sentence

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- *root* is labeled by the start symbol
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- Each internal node is labeled by a non-terminal
- If A is a non-terminal labeling an internal node and $x_1, x_2, \ldots x_n$ are labels of the children of that node, then $A \rightarrow x_1 x_2 \ldots x_n$ is a production

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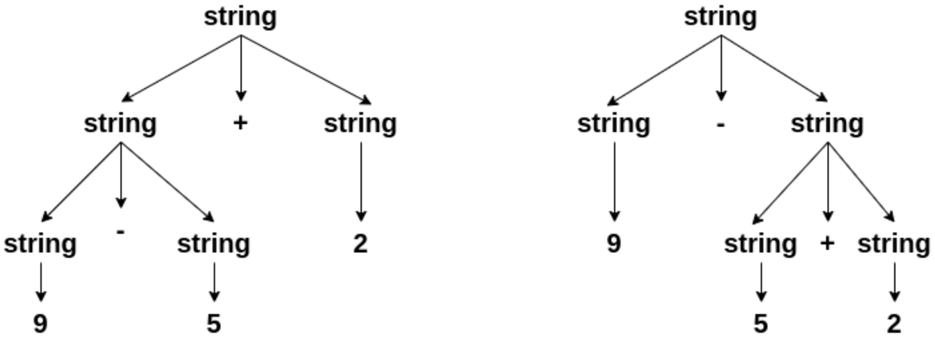

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- It is impossible to convert automatically an ambiguous grammar to an unambiguous one.

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- Precedence determines the correct interpretation.

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  - **Top-down parsing:** Construction of the parse tree starts at the root (from the start symbol) and proceeds towards leaves (token or terminals). Ex ANTLR
  - **Bottom-up parsing:** Construction of the parse tree starts from the leaf nodes (tokens or terminals of the grammar) and proceeds towards root (start symbol). Ex YACC and BISON

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Recursive Descent parsing

Algorithm A()

Choose an A-production, $A \rightarrow X_1 X_2 \cdots X_k$
for $i = 1$ to k **do**
    if X_i is a nonterminal **then**
        call procedure$X_i()$
    else if X_i equals the current input symbol α **then**
        advance the input to the next symbol
    else
        error()
    end if
end for

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- Dynamic Programming or tabular method may be used.

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  $A \rightarrow \beta_1 A'|\beta_2 A'|\cdots|\beta_n A'$
  $A' \rightarrow \alpha_1 A'|\alpha_2 A'|\cdots|\alpha_m A'|\epsilon$

Example

- Consider grammar for arithmetic expressions

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$$E \rightarrow TE'$$
$$E' \rightarrow +TE' | \epsilon$$
$$T \rightarrow FT'$$
$$T' \rightarrow *FT' | \epsilon$$
$$F \rightarrow (E) | id$$

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