Lecture 6

Syntax Analysis

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Take aways from the last class

- Extended regular expressions

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- Lexical Analyzer generator

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- Correctness check of a string based on `lex` rules

move from one transition diagram to the next diagram.

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

Overview of Syntax Analysis

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- These issues will be handled in semantic analysis

Derivation

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

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\begin{aligned}
list &\rightarrow list + digit\\
&\quad |list - digit\\
&\quad |digit\\
digit &\rightarrow 0|1|2\ldots|9
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sentential form may have non-terminals as well as terminals.

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do note the meaning of double and single arrow...

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

Parse Tree

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- 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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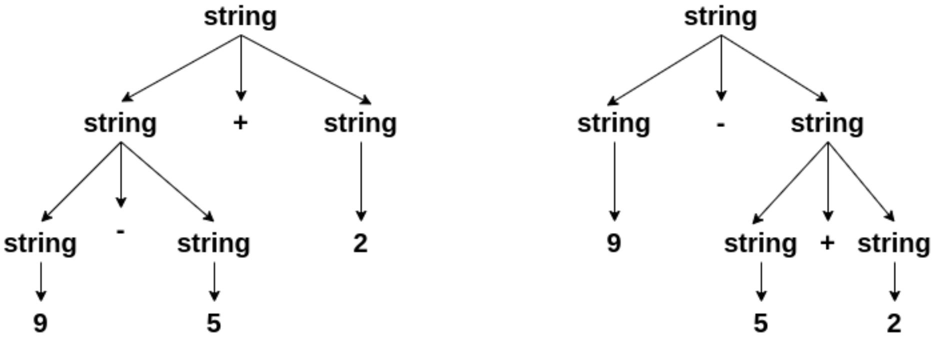

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- There are no general techniques for handling ambiguity
- It is impossible to convert automatically an ambiguous grammar to an unambiguous one.

in programming

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- Precedence determines the correct interpretation.

a = b = c means first assign the value of c to b and then b to a.

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Resolving dangling `else` problem

to resolve ambiguity, we want some disambiguating rules such as this one

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- Parsing falls in two categories:
  - **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

for every non-terminal, associate a recusive procedure to it.

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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Recursive Descent parsing

we are choosing production randomly, and it required backtracking over all the productions at any stage.

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- Require backtracking
- May require repeated scans over the input.
- Dynamic Programming or tabular method may be used.

think like backtracking is itself a non-deterministic algo.

note that using backtracking will not remove non-determinism in procedure, as we are not sure of using what production.

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- In general $A \rightarrow A\alpha_1|A\alpha_2|\cdots|A\alpha_m|\beta_1|\beta_2|\cdots|\beta_n$ transforms to

  $A \rightarrow \beta_1 A'|\beta_2 A'|\cdots|\beta_n A'$

  $A' \rightarrow \alpha_1 A'|\alpha_2 A'|\cdots|\alpha_m A'|\epsilon$

Example

- Consider grammar for arithmetic expressions

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- After removal of left recursion the grammar becomes

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

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  - Starting from the first rule and replacing all the occurrences of the first non terminal symbol.

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  $A \to bdA'|A'$
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  $A' \rightarrow \beta_1|\beta_2$

three things to remove from grammar before performing top-down parsing-
1. Ambiguity
2. Left recursion
3. Left factoring