Scribe submission –report

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-NADITOKA CHANDRASEKHAR

-11CS10030

FOLLOW(X)

For every non-terminal X, the FOLLOW() set is the collection of all terminals that can follow X in a *sentential form*. The set can be defined inductively as follows.

- The special symbol *eof* or \$ is in FOLLOW(S), where S is the start symbol.
- If $A \to \alpha B \beta$ be a production rule, $\text{FIRST}(\beta) \setminus \{\varepsilon\} \subseteq \text{FOLLOW}(B)$.
- If $A \to \alpha B \beta$, where $\beta = \varepsilon$ or $\beta \to \varepsilon$, then $\text{FOLLOW}(A) \subseteq \text{FOLLOW}(B)$.

The reason is simple:
$S \to uAv \to u\alpha B\beta v \to u\alpha Bv$, naturally $\text{FIRST}(v) \subseteq \text{FOLLOW}(A), \text{FOLLOW}(B)$.

Computation of FOLLOW() Sets

for each $A \in N$
    $\text{FOLLOW}(A) \leftarrow \emptyset$
$\text{FOLLOW}(S) \leftarrow \{\$\}$
while (FOLLOW sets are not fixed points)
    for each $A \rightarrow \beta_1\beta_2\cdots\beta_k \in P$
    if $(\beta_k \in N)$
        $\text{FOLLOW}(\beta_k) \leftarrow \text{FOLLOW}(\beta_k) \cup \text{FOLLOW}(A)$
    $FA \leftarrow \text{FOLLOW}(A)$

for $i \leftarrow k$ **downto** 2
    if $(\beta_i \in N \;\&\; \varepsilon \in \text{FOLLOW}(\beta_i))$
        $\text{FOLLOW}(\beta_{i-1}) \leftarrow \text{FOLLOW}(\beta_{i-1})$
            $\cup\ \text{FIRST}(\beta_i) \setminus \{\varepsilon\} \cup FA$
    else
        $\text{FOLLOW}(\beta_{i-1}) \leftarrow \text{FOLLOW}(\beta_{i-1})$
            $\cup\ \text{FIRST}(\beta_i) \setminus \{\varepsilon\}$
        $FA \leftarrow \emptyset$

Example

In the expression grammar G:
$\text{FOLLOW}(E) = \{\$, +,)\}$, $\text{FOLLOW}(T) = \text{FOLLOW}(E) \cup \{*\} = \{\$, +,), *\}$ and $\text{FOLLOW}(F) = \{\$, +,), *\}$.

In the transformed grammar:
$\text{FOLLOW}(E) = \text{FOLLOW}(E') = \{\$,)\}$, $\text{FOLLOW}(T) = \text{FOLLOW}(T') = \{\$,), +\}$ and $\text{FOLLOW}(F) = \{\$,), +, *\}$.

$LL(1)$ Grammar

A context-free grammar G is $LL(1)$ *iff* for any pair of distinct productions $A \to \alpha$, $A \to \beta$, the following conditions are satisfied.

- $\text{FIRST}(\alpha) \cap \text{FIRST}(\beta) = \emptyset$ i.e. no $a \in \Sigma \cup \{\varepsilon\}$ can belong to both.
- If $\alpha \to \varepsilon$, then $\text{FIRST}(\beta) \cap \text{FOLLOW}(A) = \emptyset$ and vice versa.

Example

Consider the following grammar with the set of *terminals*,
$\Sigma =$ {`id ; := int float main do else end if print scan then while`} $\cup \{\mathrm{E}\ \mathrm{BE}\}$[a];
the set of *non-terminals*,
$N =$ {`P DL D VL T SL S ES IS WS IOS`};
the start symbol is `P` and the set of production rules are:

[a] `E` and `BE`, corresponds to expression and boolean expressions, are actually *non-terminals*. But here we treat them as terminals.