Compiler Constructions

Deterministic Parsing

Chapter 16: LL(k)Grammars

Agenda :

- First
- Follow
- Lookahead
- Strong LL(k) grammar
- LL(k) grammar

- **First**

Definition 16.2.1

Let G be a context-free grammar. For every string $u \in (V \cup \Sigma)^*$ and $k > 0$, the set $\text{FIRST}_k(u)$ is defined by

$$\text{FIRST}_k(u) = trunc_k(\{x \mid u \stackrel{*}{\Rightarrow} x,\ x \in \Sigma^*\}).$$

1. $\text{FIRST}_k(\lambda) = \{\lambda\}$
2. $\text{FIRST}_k(a) = \{a\}$
3. $\text{FIRST}_k(au) = \{av \mid v \in \text{FIRST}_{k-1}(u)\}$
4. $\text{FIRST}_k(uv) = trunc_k(\text{FIRST}_k(u)\text{FIRST}_k(v))$
5. if $A \to w$ is a rule in G, then $\text{FIRST}_k(w) \subseteq \text{FIRST}_k(A)$.

$$G_2: \quad S \to ABCabcd$$
$$A \to a \mid \lambda$$
$$B \to b \mid \lambda$$
$$C \to c \mid \lambda$$

First $_1$(A)= {a, λ}

First $_1$(B)= {b, λ}

First $_1$(C)= {c, λ}

First $_2$(A)= {a, λ}

First $_2$(B)= {b, λ}

First $_2$(C)= {c, λ}

$$G_2: \quad S \rightarrow ABCabcd$$
$$A \rightarrow a \mid \lambda$$
$$B \rightarrow b \mid \lambda$$
$$C \rightarrow c \mid \lambda$$

$First_k$ (S) = $trunc_k$ (First (A). First (B).First (C). First(abcd))

FIRST sets are constructed for the strings S and ABC using the grammar G_2

$$\text{FIRST}_1(ABC) = \{a, b, c, \lambda\}$$
$$\text{FIRST}_2(ABC) = \{ab, ac, bc, a, b, c, \lambda\}$$
$$\text{FIRST}_3(S) = \{abc, aba, aca, bca, bab, cab\}$$

- **Follow:**

Let G be a context-free grammar. For every $A \in V$ and $k > 0$, the set $\text{FOLLOW}_k(A)$ is defined by

$$\text{FOLLOW}_k(A) = \{x \mid S \overset{*}{\Rightarrow} uAv \text{ and } x \in \text{FIRST}_k(v)\}.$$

The set $\text{FOLLOW}_k(A)$ consists of prefixes of terminal strings that can follow the variable A in derivations in G. Since the null string follows every derivation from the sentential form consisting solely of the start symbol, $\lambda \in \text{FOLLOW}_k(S)$.

- **Example:**

a) Give the $FIRST_2$ and $FOLLOW_2$ sets for each of the variables of the following grammar

$$G: S \rightarrow AB$$

$$A \rightarrow aC \mid bB$$

$$B \rightarrow AD \mid CA$$

$$C \rightarrow a$$

$$D \rightarrow b$$

b) Is grammar strong LL(2)?

G: S→ AB

A→ aC / bB

B→ AD /CA

C→ a

D→ b

Answer:

First :

$F(S)= F_2(A).F_2(B)$

$F_2(S)= \{ aa, ba, bb \}$

$F_2(A)= \{ aa, ba, bb \}$

$F_2(B)= \{ aa, ba, bb , ab \}$

$F_2(C)= \{ a \}$

$F_2(D)= \{ b \}$

$F_2(A)= a.F_2(C), b.F_2(B)$
$= \{aa, b.\{F_2(B) \} \}$
{ aa, ba, bb}

$F_2(B)= F_2(A). F_2(D), F_2(C).F_2(A)$

= { aa, ba, bb}, {a}. { aa, ba, bb}}
= { aa, ba,bb, ab}