

第 7 周编译原理课堂笔记

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1 自顶向下的语法分析

1.1 first 函数

$\text{first}(\alpha)$ 被定义为可从 α 推导的到的串的首符号的集合


1.2 follow 函数

对于非终结符号 A ， $\text{follow}(A)$ 被定义为可能在某些句型中紧跟在 A 右边的终结符号的集合

1. $\text{follow}(F) = \{*, +, \$, \epsilon\}$

2. $\text{follow}(T') = \{+, \$, \epsilon\}$

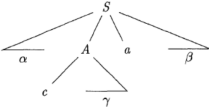
3. $\text{follow}(T) = \{+, \$, \epsilon\}$




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FIRST (α)

Define $FIRST(\alpha)$, where α is any string of grammar symbols, to be the set of terminals that begin strings derived from α . If $\alpha \Rightarrow^* \epsilon$, then ϵ is also in $FIRST(\alpha)$. For example, in Fig. 4.15, $A \Rightarrow^* c\gamma$, so c is in $FIRST(A)$.



Consider two A -productions $A \rightarrow \alpha | \beta$, where $FIRST(\alpha)$ and $FIRST(\beta)$ are disjoint. We can then choose between these A -productions by looking at the next input symbol a , since a can be in at most one of $FIRST(\alpha)$ and $FIRST(\beta)$, not both.



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Computing FIRST(X)

To compute $\text{FIRST}(X)$ for all grammar symbols X , apply the following rules until no more terminals or ϵ can be added to any FIRST set.

1. If X is a terminal, then $\text{FIRST}(X) = \{X\}$.
2. If X is a nonterminal and $X \rightarrow Y_1 Y_2 \cdots Y_k$ is a production for some $k \geq 1$, then place a in $\text{FIRST}(X)$ if for some i , a is in $\text{FIRST}(Y_i)$, and ϵ is in all of $\text{FIRST}(Y_1), \dots, \text{FIRST}(Y_{i-1})$; that is, $Y_1 \cdots Y_{i-1} \xRightarrow{*} \epsilon$. If ϵ is in $\text{FIRST}(Y_j)$ for all $j = 1, 2, \dots, k$, then add ϵ to $\text{FIRST}(X)$. For example, everything in $\text{FIRST}(Y_1)$ is surely in $\text{FIRST}(X)$. If Y_1 does not derive ϵ , then we add nothing more to $\text{FIRST}(X)$, but if $Y_1 \xRightarrow{*} \epsilon$, then we add $\text{FIRST}(Y_2)$, and so on.
3. If $X \rightarrow \epsilon$ is a production, then add ϵ to $\text{FIRST}(X)$.

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Example

$$\begin{array}{lcl} E & \rightarrow & T E' \\ E' & \rightarrow & + T E' \mid \epsilon \\ T & \rightarrow & F T' \\ T' & \rightarrow & * F T' \mid \epsilon \\ F & \rightarrow & (E) \mid \text{id} \end{array}$$

Compute the $\text{FIRST}(X)$ for each nonterminal X .



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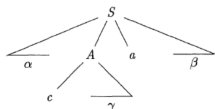


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FOLLOW(A)

$S \rightarrow aA|c$, if the next input symbol is not 'a', then will choose $S \rightarrow c$; otherwise both productions can be chosen.

Define $\text{FOLLOW}(A)$, for nonterminal A , to be the set of terminals a that can appear immediately to the right of A in some sentential form; that is, the set of terminals a such that there exists a derivation of the form $S \xRightarrow{*} \alpha A a \beta$, for some α and β



if A can be the rightmost symbol in some sentential form, then $\$$ is in $\text{FOLLOW}(A)$.



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Computing FOLLOW(A)

To compute FOLLOW(A) for all nonterminals A , apply the following rules until nothing can be added to any FOLLOW set.

1. Place $\$$ in FOLLOW(S), where S is the start symbol, and $\$$ is the input right endmarker.
2. If there is a production $A \rightarrow \alpha B \beta$, then everything in FIRST(β) except ϵ is in FOLLOW(B).
3. If there is a production $A \rightarrow \alpha B$, or a production $A \rightarrow \alpha B \beta$, where FIRST(β) contains ϵ , then everything in FOLLOW(A) is in FOLLOW(B).



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Practice

$$\begin{aligned} E &\rightarrow T E' \\ E' &\rightarrow + T E' \mid \epsilon \\ T &\rightarrow F T' \\ T' &\rightarrow * F T' \mid \epsilon \\ F &\rightarrow (E) \mid \text{id} \end{aligned}$$

Compute the FOLLOW(X) for each nonterminal X .



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4. follow $(E') = \{\$, \varepsilon\}$

5. follow $(E) = \{\$, \varepsilon\}$

1.3 LL (1) 文法

解决做产生式选择的问题

1. 预测分析器的转换图

要构造一个文法的转换图, 首先要消除左递归, 然后对文法提前左公因子。

□

2. 构造预测分析表

严重不理解第二步

Construction of a Predictive Parsing Table

INPUT: Grammar G .

OUTPUT: Parsing table M .

METHOD: For each production $A \rightarrow \alpha$ of the grammar, do the following:

1. For each terminal a in $\text{FIRST}(\alpha)$, add $A \rightarrow \alpha$ to $M[A, a]$.
2. If ϵ is in $\text{FIRST}(\alpha)$, then for each terminal b in $\text{FOLLOW}(A)$, add $A \rightarrow \alpha$ to $M[A, b]$. If ϵ is in $\text{FIRST}(\alpha)$ and $\$$ is in $\text{FOLLOW}(A)$, add $A \rightarrow \alpha$ to $M[A, \$]$ as well.

If, after performing the above, there is no production at all in $M[A, a]$, then set $M[A, a]$ to **error** (which we normally represent by an empty entry in the table). □

3. 递归预测分析

4. 非递归的预测分析 (利用到预测分析表和栈)

2 自底向上的语法分析

最左规约

2.1 移进-规约

重点在于：什么时候移进，怎么选择规约



Predictive Parsing Table

NON - TERMINAL	INPUT SYMBOL					
	id	+	*	()	\$
E	$E \rightarrow TE'$			$E \rightarrow TE'$		
E'		$E' \rightarrow +TE'$			$E' \rightarrow \epsilon$	$E' \rightarrow \epsilon$
T	$T \rightarrow FT'$			$T \rightarrow FT'$		
T'		$T' \rightarrow \epsilon$	$T' \rightarrow *FT'$		$T' \rightarrow \epsilon$	$T' \rightarrow \epsilon$
F	$F \rightarrow \text{id}$			$F \rightarrow (E)$		



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