

编译原理 chapter1~5习题

chapter1

1、何谓源程序、目标程序、翻译程序、编译程序和解释程序？它们之间可能有何种关系？

源程序：用源语言编写的程序。

目标程序：源程序经翻译程序过加工处理后生成的程序。

翻译程序：将源程序转换为与其逻辑上等价的目标程序。

编译程序：源语言为高级语言，目标语言为汇编语言或机器语言的翻译程序。

① 先翻译后执行 ② 执行速度快 ③ 多次运算

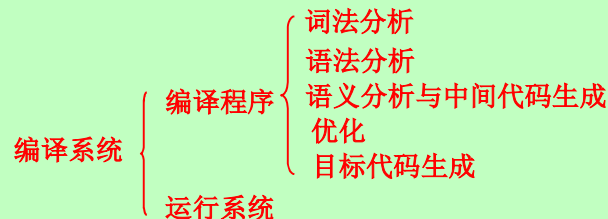
解释程序：源语言程序作为输入，但不产生目标程序，而是边解释边执行源程序本身。

① 边解释边执行 ② 有利于程序的调试 ③ 1次运算

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chapter1

2、一个典型的编译系统通常由有哪些部分组成？各部分的主要功能是什么？



```

graph LR
    A[编译系统] --- B[编译程序]
    A --- C[运行系统]
    B --- D[词法分析]
    B --- E[语法分析]
    B --- F[语义分析与中间代码生成]
    B --- G[优化]
    B --- H[目标代码生成]
  
```

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① **词法分析(Lexical Analysis):**
从左到右一个字符一个字符的读入源程序，对构成源程序的字符串进行扫描和分解，从而**识别出一个一个单词**（也称单词符号或简称符号）。

② **语法分析(Syntax Analysis):**
在词法分析的基础上将单词序列分解成各类语法短语，如“程序”，“语句”，“表达式”等等。

③ **语义分析(Syntactic Analysis):**
语义分析是在语法分析程序确定出语法短语后，审查有无语义错误，并为代码生成阶段收集类型信息。

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④ **中间代码生成(Generation of intermediate code):**
完成语法分析和语义处理工作后，编译程序将源程序变成一种内部表示形式，这种内部表示形式叫做中间语言或称中间代码，它是一种结构简单、含义明确的记号系统。

⑤ **代码优化(Optimization of code):**
为了使生成的目标代码更为高效，可以对产生的中间代码进行变换或进行改造，这就是代码的优化。

⑥ **代码生成(Generation of code):**
目标代码生成是编译器的最后一个阶段。在生成目标代码时要考虑以下几个问题：**计算机的系统结构、指令系统、寄存器的分配以及内存的组织等。**

chapter2

1. 写出C语言和Java语言的输入字母表。

C语言: 0~9数字, 大小写英文字母, 键盘上可见的字符

Java语言: Unicode可以包括的所有字符。

6. 文法 G_6 为: $N \rightarrow D|ND$
 $D \rightarrow 0|1|2|3|4|5|6|7|8|9$

(1) G_6 的语言是什么?

G_6 的语言是: 0~9的数字组成的任意非空串
 $L(G_6) = \{x | x \in \{0,1,2,3,4,5,6,7,8,9\}^+\}$

(2) 给出句子0127、34和568的最左和最右推导。

7. 写一文法, 使其语言是**奇数集**。要求: 不以0打头。

(一位): $D \rightarrow 1|3|5|7|9$

复杂的情况: 分三部分

末尾: 以1|3|5|7|9结尾 $D \rightarrow 1|3|5|7|9$

开头: 除了0的任意数字 $B \rightarrow 2|4|6|8|D$

中间部分: 空或者任意数字串 $C \rightarrow CA|\epsilon$

所以题目要求的文法 $G[N]$ 可以写成: $A \rightarrow 0|B$

$N \rightarrow BCD|D$

$D \rightarrow 1|3|5|7|9$

$B \rightarrow 2|4|6|8|D$

$C \rightarrow CA|\epsilon$

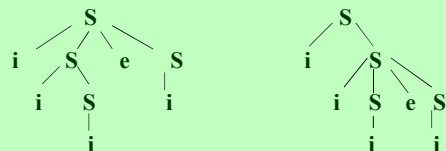
$A \rightarrow 0|B$

9. 证明文法: $S \rightarrow iSeS | iS | i$ 是二义的。

二义性的含义: 如果文法存在**某个句子**对应**两棵以上不同的语法树**, 或者**两种以上不同的最左/右推导**, 则称这个文法是二义的。

首先: 找到此文法对应的一个句子 **iiiei**

其次: 构造与之对应的**两棵**语法树



结论: 因为该文法存在句子iiiei对应两棵不同的语法树, 因而该文法是二义的。

11. 给出下面语言的相应文法

$L_1 = \{a^n b^n c^i | n \geq 1, i \geq 0\}$

从 n, i 的不同取值来把 L_1 分成两部分:

前半部分是 $a^n b^n$: $A \rightarrow aAb | ab$

后半部分是 c^i : $B \rightarrow Bc | \epsilon$

所以整个文法 $G_1[S]$ 可以写为:

$G_1(S): S \rightarrow AB$

$A \rightarrow aAb | ab$

$B \rightarrow Bc | \epsilon$

$$L_2 = \{a^i b^n c^n \mid n \geq 1, i \geq 0\}$$

$G_2(S)$: $S \rightarrow AB$
 $A \rightarrow aA \mid \varepsilon$
 $B \rightarrow bBc \mid bc$

$$L_3 = \{a^n b^n a^m b^m \mid m, n \geq 0\}$$

$G_3(S)$: $S \rightarrow AB$
 $A \rightarrow aAb \mid \varepsilon$
 $B \rightarrow aBb \mid \varepsilon$

$$L_4 = \{1^n 0^m 1^m 0^n \mid n, m \geq 0\}$$

可以看成是两部分:

中间部分是 $0^m 1^m$: $A \rightarrow 0A1 \mid \varepsilon$
 剩下两边的部分就是: $S \rightarrow 1S0 \mid A$

所以 $G_4[S]$ 可以写为:

$S \rightarrow 1S0 \mid A$
 $A \rightarrow 0A1 \mid \varepsilon$

chapter3

7. 构造下列正规式相应的 **DFA**。

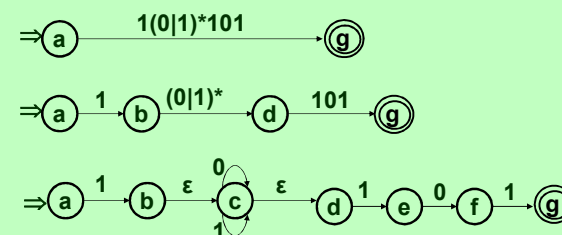
问题: 将状态转换图与 **DFA** 混淆。

步骤:

- ①. 根据正规式画出对应的 **状态转换图**;
- ②. 根据状态转换图画出对应的 **状态转换矩阵**;
- ③. 根据状态转换矩阵得到 **重命名后的状态转换矩阵**;
- ④. 根据重命名后的状态转换矩阵得出最后的 **DFA**。

$$1(0|1)^*101$$

①. 状态转换图



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②.状态转换矩阵

I	I ₀	I ₁
{a}	Φ	{b,c,d}
{b,c,d}	{c,d}	{c,d,e}
{c,d}	{c,d}	{c,d,e}
{c,d,e}	{c,d,f}	{c,d,e}
{c,d,f}	{c,d}	{c,d,e,g}
{c,d,e,g}	{c,d,f}	{c,d,e}

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④.DFA

I	I ₀	I ₁
{a}	Φ	{b,c,d}
{b,c,d}	{c,d}	{c,d,e}
{c,d}	{c,d}	{c,d,e}
{c,d,e}	{c,d,f}	{c,d,e}
{c,d,f}	{c,d}	{c,d,e,g}
{c,d,e,g}	{c,d,f}	{c,d,e}

③. 重命名后的状态转换矩阵

S	0	1
A(始态)	Φ	B
B	C	D
C	C	D
D	E	D
E	C	F(终态)
F(终态)	E	D

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①.状态转换图

1(1010*|1(010)*1)*0

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②.状态转换矩阵

I	I ₀	I ₁
{0}	Φ	{1,2,3}
{1,2,3}	{4}	{5,9,10,11}
{5,9,10,11}	{6,12}	{2,3}
{6,12}	Φ	{2,3,7,8,13}
{2,3}	{4}	{5,9,10,11}
{2,3,7,8,13}	{2,3,4,8,10,11}	{5,9,10,11}
{2,3,4,8,10,11}	{2,3,4,8,12}	{2,3,5,9,10,11}
{2,3,4,8,12}	{2,3,4,8}	{5,9,10,11,13}
{2,3,5,9,10,11}	{4,6,12}	{2,3,5,9,10,11}
{2,3,4,8}	{2,3,4,8}	{5,9,10,11}
{5,9,10,11,13}	{6,10,11,12}	{2,3}
{4,6,12}	Φ	{2,3,7,8,13}
{6,10,11,12}	{12}	{2,3,7,8,13}
{12}	Φ	{13}
{13}	{10,11}	Φ
{10,11}	{12}	{2,3}

③. 重命名后的状态转换矩阵 ④.DFA

I	I ₀	I ₁
1	Φ	2
2	3	4
4	5	6
5	Φ	7
6	3	4
7	8	4
8	9	10
9	11	12
10	13	10
11	11	4
12	14	6
13	Φ	7
14	15	7
15	Φ	16
16	17	Φ
17	15	6

8、给出下面正规表达式

(1) 以01结尾的二进制数串。

 $(0|1)^*01$

(2) 能被5整除的十进制数。

 $0|5|(1|2|3|4|5|6|7|8|9)(0|1|2|3|4|5|6|7|8|9)^*(0|5)$

(3) 包含奇数个1或奇数个0的二进制串

 $0^*1(0|10^*1)^*|1^*0(0|10^*1)^*$

(4) 英文字母组成的所有符号串，要求符号串中的字母按字典序排列。

 $(A|a)^*(B|b)^*(C|c)^*\dots(Z|z)^*$

8、给出下面正规表达式

(5) 没有重复出现的数字的数字符号串的全集

令 $r_i = i|ε$, $i=0,1,2,\dots,9$ $R0|R1|R2|\dots|R9$ 记为 $\sum R_i$ $i \in (0,1,2,\dots,9)$ $P(0,1,2,\dots,9)$ 表示 $0,1,2,\dots,9$ 的全排列 $\sum r_{i_0}r_{i_1}\dots r_{i_9}$ $r_{i_0}r_{i_1}\dots r_{i_9} \in P(0,1,2,\dots,9)$

(6) 最多有一个重复出现的数字的数字符号串的全集

 $\sum_i \sum r_{i_0}r_{i_1}\dots r_{i_9}$ $i \in (0,1,2,\dots,9)$ $r_{i_0}r_{i_1}\dots r_{i_9} \in P(0,1,2,\dots,9)$

(7) 不包含字符串abb的由a和b组成的符号串的全集

 $b^*(a^*(ba)^*)^*$

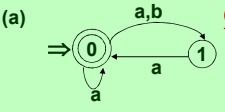
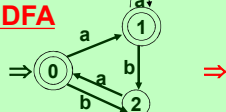
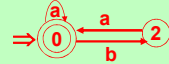
9、对下面情况给出DFA及正规表达式:

(1) $\{0,1\}$ 上的含有子串010的所有串。正规式: $(0|1)^*010(0|1)^*$ (2) $\{0,1\}$ 上不含子串010的所有串。正规式: $1^*(0|11^*1)^*$ $1^*(0|11)^*1^*1^*0^*1^*(0|11)^*(0|1)$

DFA做法同第7题。

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12、将图3.18的(a)和(b)分别确定化和最少化。

(a)  ③.DFA  

①.状态转换矩阵 ②.重命名后的状态转换矩阵

I	I _a	I _b
{0}	{0,1}	{1}
{0,1}	{0,1}	{1}
{1}	{0}	φ

I	I _a	I _b
0	1	2
1	1	2
2	0	φ

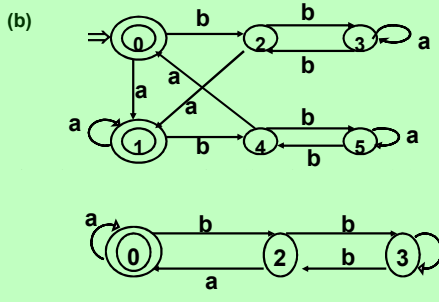
④.最小化

$\Pi_0 = (\{0,1\}, \{2\})$

$\{0,1\}_a = \{1\}$
 $\{0,1\}_b = \{2\}$

因此,不能再分

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(b) 

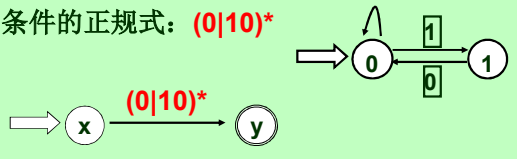
$\{2, 4\}_a = \{0, 1\}$ $\{2, 4\}_b = \{3, 5\}$ 所以2, 4等价
 $\{3, 5\}_a = \{3, 5\}$ $\{3, 5\}_b = \{2, 4\}$ 所以3, 5等价
 所以分为 $\{0, 1\}$ $\{2, 4\}$ $\{3, 5\}$

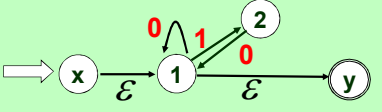
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14、构造一个DFA, 它接受 $\Sigma=\{0,1\}$ 上所有满足如下条件的字符串: 每个1都有0直接跟在右边。

思路: 先写出满足条件的正规式, 由正规式构造NFA, 再把NFA确定化和最小化。

满足条件的正规式: $(0|10)^*$





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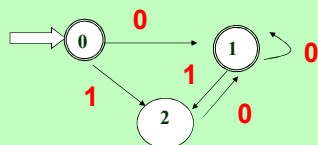
确定化:

	0	1
{X, 1, Y}	{1, Y}	{2}
{1, Y}	{1, Y}	{2}
{2}	{1, Y}	φ

给状态编号:

	0	1
0	1	2
1	1	2
2	1	φ

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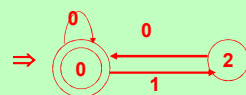
最小化:

$\{0,1\}, \{2\}$

$\{0,1\}_0 = \{1\} \quad \{0,1\}_1 = \{2\}$

$\{2\}_0 = \{0\}, \{2\}_1 = \emptyset \subseteq \{2\}$ 或 $\{0,1\}$

所以 $\{0,1\}$ 不可分, 用状态0代表它们



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15、给定右线性文法G: 求一个与G等价的左线性文法。

$S \rightarrow 0S \mid 1S \mid 1A \mid 0B$

$A \rightarrow 1C \mid 1$

$B \rightarrow 0C \mid 0$

$C \rightarrow 0C \mid 1C \mid 0 \mid 1$

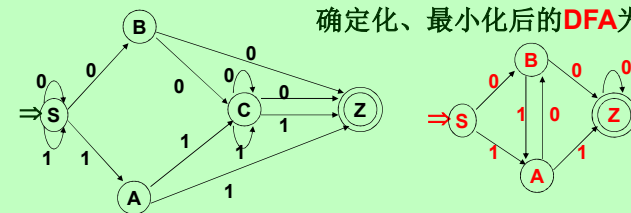
$G[Z]:$

$Z \rightarrow Z0 \mid Z1 \mid B0 \mid A1$

$B \rightarrow A0 \mid 0$

$A \rightarrow B1 \mid 1$

确定化、最小化后的DFA为:



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补充: 构造一右线性文法, 使它与如下文法等价:

$S \rightarrow AB \quad A \rightarrow UT \quad U \rightarrow a|aU \quad T \rightarrow b|bT \quad B \rightarrow c|cB$

并根据所得右线性文法, 构造出相应的状态转换图。

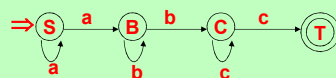
思路:

先写出原文法所描述的语言 $L(G) = \{a^m b^n c^k \mid m, n, k \geq 1\}$

$G[S]: S \rightarrow aS|aB$

$B \rightarrow bB|bC$

$C \rightarrow cC|c$



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chapter4

4.1、考虑下面文法G1: $S \rightarrow a \mid \wedge \mid (T)$

$T \rightarrow T, S \mid S$

(1) 消去G1的左递归;

$S \rightarrow a \mid \wedge \mid (T)$

$T \rightarrow ST'$

$T' \rightarrow , S T' \mid \epsilon$

(2) 经改写后的文法是否是LL(1)文法, 给出预测分析表。

经改写后的文法满足3个条件, 所以是LL(1)的

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预测分析表构造算法:

1.对文法中的每个产生式 $A \rightarrow \alpha$ 执行第二步和第三步;

$FIRST(S) = \{a, \wedge, \}$ $FIRST(T) = \{a, \wedge, \}$ $FIRST(T') = \{, , \epsilon\}$

$FOLLOW(S) = \{, , \# \}$ $FOLLOW(T) = \{ \}$ $FOLLOW(T') = \{ \}$

	a	\wedge	(,)	#
S	$S \rightarrow a$	$S \rightarrow \wedge$	$S \rightarrow (T)$			
T	$T \rightarrow ST'$	$T \rightarrow ST'$	$T \rightarrow ST'$			
T'				$T' \rightarrow ,ST'$	$T' \rightarrow \epsilon$	

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预测分析表构造算法:

1.对文法中的每个产生式 $A \rightarrow \alpha$ 执行第二步和第三步;

$S \rightarrow a; S \rightarrow \wedge; S \rightarrow (T); T \rightarrow ST'; T' \rightarrow ,ST' T' \rightarrow \epsilon$

2.对每个终结符 $a \in FIRST(\alpha)$,把 $A \rightarrow a$ 加到 $M[A,a]$ 中;

$FIRST(a) = \{a\}$

$FIRST(\wedge) = \{\wedge\}$

$FIRST((T)) = \{(\}$

$FIRST(ST') = \{a, \wedge, (\}$

$FIRST(,ST') = \{, \}$

$FIRST(\epsilon) = \{\epsilon\}$

3.若 $\epsilon \in FIRST(\alpha)$,则对于任何 $b \in FOLLOW(A)$ 把 $A \rightarrow \alpha$ 加至 $M[A,b]$ 中

$FOLLOW(T') = FOLLOW(T) = \{ \}$

	a	\wedge	(,)	#
S	$S \rightarrow a$	$S \rightarrow \wedge$	$S \rightarrow (T)$			
T	$T \rightarrow ST'$	$T \rightarrow ST'$	$T \rightarrow ST'$			
T'				$T' \rightarrow ,ST'$	$T' \rightarrow \epsilon$	

编译原理 chapter1~5习题

递归子程序:

procedure S;

begin

 if sym='a' or sym='^'

 then advance

 else if sym='('

 then begin

 advance;T;

 if sym=')' then advance;

 else error;

 end

 else error

end;

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procedure T;

begin

 S;T'

End

procedure T';

begin

 if sym=','

 then begin

 advance;

 S;T'

 end

End

sym:是输入串指针IP所指的符号

advance:是把IP调至下一个输入符号

error:是出错诊断程序

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补充题：有文法：

$$E \rightarrow TE'$$

$$E' \rightarrow ATE' \mid \varepsilon$$

$$T \rightarrow FT'$$

$$T' \rightarrow MFT' \mid \varepsilon$$

$$F \rightarrow (E) \mid i$$

$$A \rightarrow + \mid -$$

$$M \rightarrow * \mid /$$

- (1) 求First、Follow集，判断是否是LL(1)文法？
- (2) 若是构造LL(1)分析表？
- (3) 简述LL(1)分析器的工作原理。

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4.2：有文法：

$$E \rightarrow TE'$$

$$E' \rightarrow +E \mid \varepsilon$$

$$T \rightarrow FT'$$

$$T' \rightarrow T \mid \varepsilon$$

$$F \rightarrow PF'$$

$$F' \rightarrow *F' \mid \varepsilon$$

$$P \rightarrow (E) \mid a \mid b \mid \wedge$$

- (1) 求First、Follow集，判断是否是LL(1)文法？
- (2) 若是构造LL(1)分析表？
- (3) 简述LL(1)分析器的工作原理。

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	i	+	-	*	/	()	#
E	$E \rightarrow TE'$						$E \rightarrow TE'$	
E'		$E \rightarrow ATE'$	$E \rightarrow ATE'$				$E' \rightarrow \varepsilon$	$E' \rightarrow \varepsilon$
T	$T \rightarrow FT'$						$T \rightarrow FT'$	
T'		$T' \rightarrow \varepsilon$	$T' \rightarrow \varepsilon$	$T' \rightarrow MFT'$	$T' \rightarrow MFT'$		$T' \rightarrow \varepsilon$	$T' \rightarrow \varepsilon$
F	$F \rightarrow i$					$F \rightarrow (E)$		
A		$A \rightarrow +$	$A \rightarrow -$					
M				$M \rightarrow *$	$M \rightarrow /$			

$$\text{FIRST}(E) = \{(, i\}$$

$$\text{FIRST}(E') = \{+, -, \varepsilon\}$$

$$\text{FIRST}(T) = \{(, i\}$$

$$\text{FIRST}(T') = \{*, /, \varepsilon\}$$

$$\text{FIRST}(F) = \{(, i\}$$

$$\text{FIRST}(A) = \{+, -\}$$

$$\text{FIRST}(M) = \{*, /\}$$

$$\text{FOLLOW}(E) = \{#, \}$$

$$\text{FOLLOW}(E') = \{#, \}$$

$$\text{FOLLOW}(T) = \{+, -, \#, \}$$

$$\text{FOLLOW}(T') = \{+, -, \#, \}$$

$$\text{FOLLOW}(F) = \{*, /, +, -, \#, \}$$

$$\text{FOLLOW}(A) = \{(, i\}$$

$$\text{FOLLOW}(M) = \{(, i\}$$

编译原理 chapter1~5习题

	(	a	b	\wedge	+	*)	#
E	$E \rightarrow TE'$	$E \rightarrow TE'$	$E \rightarrow TE'$	$E \rightarrow TE'$				
E'					$E' \rightarrow +E$		$E' \rightarrow \varepsilon$	$E' \rightarrow \varepsilon$
T	$T \rightarrow FT'$	$T \rightarrow FT'$	$T \rightarrow FT'$	$T \rightarrow FT'$				
T'	$T' \rightarrow T$	$T' \rightarrow T$	$T' \rightarrow T$	$T' \rightarrow T$	$T' \rightarrow \varepsilon$		$T' \rightarrow \varepsilon$	$T' \rightarrow \varepsilon$
F	$F \rightarrow PF'$	$F \rightarrow PF'$	$F \rightarrow PF'$	$F \rightarrow PF'$				
F'	$F' \rightarrow \varepsilon$	$F' \rightarrow \varepsilon$	$F' \rightarrow \varepsilon$	$F' \rightarrow \varepsilon$	$F' \rightarrow \varepsilon$	$F' \rightarrow F'$	$F' \rightarrow \varepsilon$	$F' \rightarrow \varepsilon$
P	$P \rightarrow (E)$	$P \rightarrow a$	$P \rightarrow b$	$P \rightarrow \wedge$				

$$1) \text{FIRST}(E) = \text{FIRST}(T) = \text{FIRST}(F) = \text{FIRST}(P) = \{(, a, b, \wedge\}$$

$$\text{FIRST}(E') = \{+, \varepsilon\}$$

$$\text{FIRST}(F') = \{*, \varepsilon\}$$

$$\text{FIRST}(T') = \text{FIRST}(T) \cup \{\varepsilon\} = \{(, a, b, \wedge, \varepsilon\}$$

$$\text{FOLLOW}(E) = \{#, \}$$

$$\text{FOLLOW}(E') = \text{FOLLOW}(E) = \{#, \}$$

$$\text{FOLLOW}(T) = \text{FIRST}(E') \setminus \varepsilon \cup \text{FOLLOW}(E) = \{+, \#, \}$$

$$\text{FOLLOW}(T') = \text{FOLLOW}(T) = \{+, \#, \}$$

$$\text{FOLLOW}(F) = \text{FIRST}(T') \setminus \varepsilon \cup \text{FOLLOW}(T) = \{(, a, b, \wedge, +, \#, \}$$

$$\text{FOLLOW}(F') = \text{FOLLOW}(F) = \{(, a, b, \wedge, +, \#, \}$$

$$\text{FOLLOW}(P) = \text{FIRST}(F') \setminus \varepsilon \cup \text{FOLLOW}(F) = \{*, (, a, b, \wedge, +, \#, \}$$

编译原理 chapter1~5习题

- 2)考虑下列产生式:
- $\text{FIRST}(+E) \cap \text{FIRST}(\epsilon) = \{+\} \cap \{\epsilon\} = \varnothing$
- $\text{FIRST}(+E) \cap \text{FOLLOW}(E') = \{+\} \cap \{\#, \epsilon\} = \varnothing$
- $\text{FIRST}(T) \cap \text{FIRST}(\epsilon) = \{(, a, b, ^\wedge\} \cap \{\epsilon\} = \varnothing$
- $\text{FIRST}(T) \cap \text{FOLLOW}(T') = \{(, a, b, ^\wedge\} \cap \{+, \epsilon, \#\} = \varnothing$
- $\text{FIRST}(*F') \cap \text{FIRST}(\epsilon) = \{*\} \cap \{\epsilon\} = \varnothing$
- $\text{FIRST}(*F') \cap \text{FOLLOW}(F') = \{*\} \cap \{(, a, b, ^\wedge, +, \epsilon, \#\} = \varnothing$
- $\text{FIRST}((E)) \cap \text{FIRST}(a) \cap \text{FIRST}(b) \cap \text{FIRST}(\epsilon) = \varnothing$
- 所以,该文法为LL(1)文法.

编译原理 chapter1~5习题

3)预测分析表:

	(	a	b	\wedge	+	*)	#
E	$E \rightarrow TE'$	$E \rightarrow TE'$	$E \rightarrow TE'$	$E \rightarrow TE'$				
E'					$E' \rightarrow +E$		$E' \rightarrow \epsilon$	$E' \rightarrow \epsilon$
T	$T \rightarrow FT'$	$T \rightarrow FT'$	$T \rightarrow FT'$	$T \rightarrow FT'$				
T'	$T' \rightarrow T$	$T' \rightarrow T$	$T' \rightarrow T$	$T' \rightarrow T$	$T' \rightarrow \epsilon$		$T' \rightarrow \epsilon$	$T' \rightarrow \epsilon$
F	$F \rightarrow PF'$	$F \rightarrow PF'$	$F \rightarrow PF'$	$F \rightarrow PF'$				
F'	$F' \rightarrow \epsilon$	$F' \rightarrow \epsilon$	$F' \rightarrow \epsilon$	$F' \rightarrow \epsilon$	$F' \rightarrow \epsilon$	$F' \rightarrow F'$	$F' \rightarrow \epsilon$	$F' \rightarrow \epsilon$
P	$P \rightarrow (E)$	$P \rightarrow a$	$P \rightarrow b$	$P \rightarrow \wedge$				

编译原理 chapter1~5习题

```

4)程序
procedure E;
begin
    if sym='(' or sym='a' or sym='b' or sym='^'
    then begin T; E' end
    else error
end
procedure E';
begin
    if sym='+'
    then begin advance; E end
    else if sym<>')' and sym<>'#' then error
end
procedure T;
begin
    if sym='(' or sym='a' or sym='b' or sym='^'
    then begin F; T' end
    else error
end

```

编译原理 chapter1~5习题

```

procedure T';
begin
    if sym='(' or sym='a' or sym='b' or sym='^'
    then T
    else if sym='*' then error
end
procedure F;
begin
    if sym='(' or sym='a' or sym='b' or sym='^'
    then begin P; F' end
    else error
end
procedure F';
begin
    if sym='*'
    then begin advance; F' end
end

```

编译原理 chapter1~5习题

```

procedure P;
begin
  if sym='a' or sym='b' or sym='^'
  then advance
  else if sym='(' then
    begin
      advance; E;
      if sym=')' then advance
      else error
    end
  else error
end;

```

编译原理 chapter1~5习题

- 4.3下面文法中，那些是LL(1)文法的，说明理由
- 构造不带回溯的自上而下分析的文法条件
 1. 文法不含左递归，
 2. 对于文法中每一个非终结符A的各个产生式的候选首符集两两不相交。即，若 $A \rightarrow \alpha_1 | \alpha_2 | \dots | \alpha_n$ 则 $FIRST(\alpha_i) \cap FIRST(\alpha_j) = \emptyset \quad (i \neq j)$
 3. 对文法中的每个非终结符A，若它存在某个候选首符集包含 ϵ ，则 $FIRST(A) \cap FOLLOW(A) = \emptyset$
 如果一个文法G满足以上条件，则称该文法G为 **LL(1)文法**。

编译原理 chapter1~5习题

<p>4.3.1</p> <p>$S \rightarrow Abc$</p> <p>$A \rightarrow a | \epsilon$</p> <p>$B \rightarrow b | \epsilon$</p> <p>是，满足三个条件</p>	<p>4.3.2</p> <p>$S \rightarrow Ab$</p> <p>$A \rightarrow a | B | \epsilon$</p> <p>$B \rightarrow b | \epsilon$</p> <p>对于A不满足条件3</p>
<p>4.3.3</p> <p>$S \rightarrow ABBA$</p> <p>$A \rightarrow a | \epsilon$</p> <p>$B \rightarrow b | \epsilon$</p> <p>A、B都不满足条件3</p>	<p>4.3.4</p> <p>$S \rightarrow aSe | B$</p> <p>$B \rightarrow bBe | \epsilon$</p> <p>$C \rightarrow cCe | d$</p> <p>满足条件3</p>

编译原理 chapter1~5习题

- 4.4对下面的文法：
 - $Expr \rightarrow -Expr$
 - $Expr \rightarrow (Expr) | Var ExprTail$
 - $ExprTail \rightarrow -Expr | \epsilon$
 - $Var \rightarrow id VarTail$
 - $VarTail \rightarrow (Expr) | \epsilon$
- (1)构造LL(1)分析表
- (2)给出对句子 $id - id((id))$ 的分析过程

解题思路：构造文法的预测分析表，通常应按下列步骤进行：

1. 消除文法的左递归（包括所有直接左递归和间接左递归）
2. 对消除左递归后的文法，提取公因子
3. 对经过上述改造后的文法，计算它的每个非终结符的FIRST集合和FOLLOW集合：
4. 根据FIRST集合和FOLLOW集合构造预测分析表：
 - 第1步对文法G的每个产生式 $A \rightarrow \alpha$ 执行第1步和第3步；
 - 第2步对每个终结符 $a \in FIRST(\alpha)$ ，把 $A \rightarrow \alpha$ 加至 $M[A, a]$ 中；
 - 第3步若 $\epsilon \in FIRST(\alpha)$ ，则对任何 $b \in FOLLOW(A)$ ，把 $A \rightarrow \alpha$ 加至 $M[A, b]$ 中；
 - 第4步把所有无定义的 $M[A, a]$ 标上“出错标志”

编译原理 chapter1~5习题

4.4對下面的文法：

- $\text{Expr} \rightarrow -\text{Expr}$
- $\text{Expr} \rightarrow (\text{Expr}) | \text{Var ExprTail}$
- $\text{ExprTail} \rightarrow -\text{Expr} | \epsilon$
- $\text{Var} \rightarrow \text{id VarTail}$
- $\text{VarTail} \rightarrow (\text{Expr}) | \epsilon$

(1)構造LL(1)分析表
(2)給出對句子id- - id((id))分析過程

解答：

$\text{FIRST}(\text{Expr}) = \{-, (, \text{id}\}$	$\text{FOLLOW}(\text{Expr}) = \{), \#\}$
$\text{FIRST}(\text{ExprTail}) = \{-, \epsilon\}$	$\text{FOLLOW}(\text{ExprTail}) = \{), \#\}$
$\text{FIRST}(\text{Var}) = \{\text{id}\}$	$\text{FOLLOW}(\text{Var}) = \{-, \#\}$
$\text{FIRST}(\text{VarTail}) = \{(\, \epsilon\}$	$\text{FOLLOW}(\text{VarTail}) = \{-, \epsilon, \#\}$

编译原理 chapter1~5习题

4.4對下面的文法：

- $\text{Expr} \rightarrow -\text{Expr}$
- $\text{Expr} \rightarrow (\text{Expr}) | \text{Var ExprTail}$
- $\text{ExprTail} \rightarrow -\text{Expr} | \epsilon$
- $\text{Var} \rightarrow \text{id VarTail}$
- $\text{VarTail} \rightarrow (\text{Expr}) | \epsilon$

(1)構造LL(1)分析表
(2)給出對句子id- - id((id))分析過程

	-	id	()	#
Expr	$\text{Expr} \rightarrow -\text{Expr}$	$\text{Expr} \rightarrow \text{Var ExprTail}$	$\text{Expr} \rightarrow (\text{Expr})$		
ExprTail	$\text{ExprTail} \rightarrow -\text{Expr}$			$\text{ExprTail} \rightarrow \epsilon$	$\text{ExprTail} \rightarrow \epsilon$
Var		$\text{Var} \rightarrow \text{id VarTail}$			
VarTail	$\text{VarTail} \rightarrow \epsilon$		$\text{VarTail} \rightarrow (\text{Expr})$	$\text{VarTail} \rightarrow \epsilon$	$\text{VarTail} \rightarrow \epsilon$

编译原理 chapter1~5习题

	-	id	()	#
Expr	$\text{Expr} \rightarrow -\text{Expr}$	$\text{Expr} \rightarrow \text{Var ExprTail}$	$\text{Expr} \rightarrow (\text{Expr})$		
ExprTail	$\text{ExprTail} \rightarrow -\text{Expr}$			$\text{ExprTail} \rightarrow \epsilon$	$\text{ExprTail} \rightarrow \epsilon$
Var		$\text{Var} \rightarrow \text{id VarTail}$			
VarTail	$\text{VarTail} \rightarrow \epsilon$		$\text{VarTail} \rightarrow (\text{Expr})$	$\text{VarTail} \rightarrow \epsilon$	$\text{VarTail} \rightarrow \epsilon$

(2)給出對句子id- - id((id))分析過程

步驟	符號棧	輸入串	所用產生式
0	#Expr	id- - id((id))#	開始
1	#ExprTail var	id- - id((id))#	$\text{Expr} \rightarrow \text{Var ExprTail}$
2	#ExprTail varTail id	id- - id((id))#	$\text{Var} \rightarrow \text{id VarTail}$
3	#ExprTail varTail	- - id((id))#	出棧，輸入串後移
4	#ExprTail	- - id((id))#	$\text{VarTail} \rightarrow \epsilon$
5	#Expr -	- - id((id))#	$\text{ExprTail} \rightarrow -\text{Expr}$

编译原理 chapter1~5习题

	-	id	()	#
Expr	$\text{Expr} \rightarrow -\text{Expr}$	$\text{Expr} \rightarrow \text{Var ExprTail}$	$\text{Expr} \rightarrow (\text{Expr})$		
ExprTail	$\text{ExprTail} \rightarrow -\text{Expr}$			$\text{ExprTail} \rightarrow \epsilon$	$\text{ExprTail} \rightarrow \epsilon$
Var		$\text{Var} \rightarrow \text{id VarTail}$			
VarTail	$\text{VarTail} \rightarrow \epsilon$		$\text{VarTail} \rightarrow (\text{Expr})$	$\text{VarTail} \rightarrow \epsilon$	$\text{VarTail} \rightarrow \epsilon$

(2)給出對句子id- - id((id))分析過程

步驟	符號棧	輸入串	所用產生式
5	#Expr -	- - id((id))#	$\text{ExprTail} \rightarrow -\text{Expr}$
6	#Expr	- id((id))#	出棧，輸入串後移
7	#Expr -	- id((id))#	$\text{Expr} \rightarrow -\text{Expr}$
8	#Expr	id((id))#	出棧，輸入串後移
9	#ExprTail Var	id((id))#	$\text{Expr} \rightarrow \text{Var ExprTail}$
10	#ExprTail VarTail id	id((id))#	$\text{Var} \rightarrow \text{id VarTail}$
11	#ExprTail VarTail	((id))#	出棧，輸入串後移

编译原理 chapter1~5习题					
	-	id	()	#
Expr	Expr→-Expr	Expr→Var ExprTail	Expr→(Expr)		
ExprTail	ExprTail→-Expr			ExprTail→ε	ExprTail→ε
Var		Var→id VarTail			
VarTail	VarTail→ε		VarTail→(Expr)	VarTail→ε	VarTail→ε

(2) 给出对句子 id - id((id)) 的分析过程

步骤	符号栈	输入串	所用产生式
11	#ExprTail VarTail	((id))#	出栈, 输入串后移
12	#ExprTail)Expr(	((id))#	VarTail→(Expr)
13	#ExprTail)Expr	(id)#	出栈, 输入串后移
14	#ExprTail))Expr(	(id)#	Expr→(Expr)
15	#ExprTail))Expr	id)#	出栈, 输入串后移
16	#ExprTail))ExprTail Var	id)#	Expr→Var ExprTail
17	#ExprTail))ExprTail VarTail id	id)#	Var→id VarTail

编译原理 chapter1~5习题					
	-	id	()	#
Expr	Expr→-Expr	Expr→Var ExprTail	Expr→(Expr)		
ExprTail	ExprTail→-Expr			ExprTail→ε	ExprTail→ε
Var		Var→id VarTail			
VarTail	VarTail→ε		VarTail→(Expr)	VarTail→ε	VarTail→ε

(2) 给出对句子 id - id((id)) 的分析过程

步骤	符号栈	输入串	所用产生式
17	#ExprTail)) ExprTail VarTail id	id)#	Var→id VarTail
18	#ExprTail)) ExprTail VarTail	)#	出栈, 输入串后移
19	#ExprTail)) ExprTail	)#	VarTail→ε
20	#ExprTail ))	)#	ExprTail→ε
21	#ExprTail)	#	出栈, 输入串后移
22	#ExprTail	#	出栈, 输入串后移
23	#	#	ExprTail→ε

成功

编译原理 chapter1~5习题	
chapter5	
1、令文法G1为:	
$E \rightarrow E+T \mid T$ $T \rightarrow T^*F \mid F$ $F \rightarrow (E) \mid i$	
证明E+T*F是它的一个句型, 指出这个句型的所有短语、直接短语和句柄。	
<p>T*F是句型E+T*F相对于T的短语</p> <p>E+T*F句型E+T*F相对于E的短语</p> <p>T*F是句型E+T*F相对于T的直接短语</p> <p>T*F是句柄</p>	

编译原理 chapter1~5习题	
2、考虑下面的表格结构文法G ₂ :	
$S \rightarrow a \mid ^ \mid (T)$ $T \rightarrow T,S \mid S$	
(1) 给出(a,(a,a))和(((a,a),^(a)),a)的最左和最右推导。	
<p>(a,(a,a))的最左推导:</p> $S \Rightarrow (T) \Rightarrow (T,S) \Rightarrow (S,S) \Rightarrow (a,S) \Rightarrow (a,(T))$ $\Rightarrow (a,(T,S)) \Rightarrow (a,(S,S)) \Rightarrow (a,(a,S)) \Rightarrow (a,(a,a))$	
<p>(((a,a),^(a)),a)的最左推导:</p> $S \Rightarrow (T) \Rightarrow (T,S) \Rightarrow (S,S) \Rightarrow ((T),S) \Rightarrow ((T,S),S)$ $\Rightarrow ((T,S,S),S) \Rightarrow ((S,S,S),S) \Rightarrow (((T,S),S,S),S)$ $\Rightarrow (((S,S),S,S),S) \Rightarrow (((a,S),S,S),S) \Rightarrow (((a,a),S,S),S)$ $\Rightarrow (((a,a),^,S),S) \Rightarrow (((a,a),^,a),S) \Rightarrow (((a,a),^,a),a)$	

编译原理 chapter1~5习题

$(a, (a, a))$ 的最右推导:

$$S \Rightarrow (T) \Rightarrow (T, S) \Rightarrow (T, (T)) \Rightarrow (T, (T, S)) \Rightarrow (T, (T, a)) \Rightarrow (T, (S, a)) \Rightarrow (T, (a, a)) \Rightarrow (S, (a, a)) \Rightarrow (a, (a, a))$$

$((a, a), ^, (a)), a$ 的最右推导:

$$S \Rightarrow (T) \Rightarrow (T, S) \Rightarrow (S, S) \Rightarrow (S, a) \Rightarrow ((T), a) \Rightarrow ((T, S, S), S) \Rightarrow ((S, S, S), S) \Rightarrow (((T, S), S, S), S) \Rightarrow (((S, S), S, S), S) \Rightarrow (((a, S), S, S), S) \Rightarrow (((a, a), S, S), S) \Rightarrow (((a, a), ^, S), S) \Rightarrow (((a, a), ^, a), S) \Rightarrow (((a, a), ^, a), a)$$

编译原理 chapter1~5习题

2) 指出 $((a, a), ^, (a)), a$ 的规范归约及每一步的句柄。

句型	句柄	归约规则
$((T, a), a)$	a	$S \rightarrow a$
$((a, a), ^, (a)), a$	a	$S \rightarrow a$
$((S, a), ^, (a)), a$	S	$T \rightarrow S$
$((T, a), ^, (a)), a$	a	$S \rightarrow a$
$((T, S), ^, (a)), a$	T, S	$T \rightarrow T, S$
$((T, ^, (a)), a)$	(T)	$S \rightarrow (T)$
$((S, ^, (a)), a)$	S	$T \rightarrow S$
$((T, ^, (a)), a)$	$^$	$S \rightarrow ^$
$((T, S, a), a)$	T, S	$T \rightarrow T, S$

编译原理 chapter1~5习题

根据这个规范规约, 给出“移进—归约”的过程, 并给出它的语法树的自下而上的构造过程。

输入串: $((a, a), ^, (a)), a$

符号栈

句柄	归约规则
a	$S \rightarrow a$
S	$T \rightarrow S$
a	$S \rightarrow a$
T, S	$T \rightarrow T, S$
(T)	$S \rightarrow (T)$
S	$T \rightarrow S$
$^$	$S \rightarrow ^$
T, S	$T \rightarrow T, S$

编译原理 chapter1~5习题

3、(1) 计算练习2文法G2的FIRSTVT和LASTVT。

G2: $S \rightarrow a \mid ^ \mid (T)$
 $T \rightarrow T, S \mid S$

FIRSTVT(S) = { $a, ^, ($ } FIRSTVT(T) = { $,, a, ^, ($ }

LASTVT(S) = { $a, ^,)$ } LASTVT(T) = { $,, a, ^,)$ }

	a	$^$	$($	$)$	$,$	$\#$
a				$>$	$>$	$>$
$^$				$>$	$>$	$>$
$($	$<$	$<$	$<$	$=$	$<$	
$)$				$>$	$>$	$>$
$,$	$<$	$<$	$<$	$>$	$>$	
$\#$	$<$	$<$	$<$			$=$

1、文法是算术文法, 且不含 ϵ 产生式。

2、由优先关系矩阵可知, 任何两个终结符之间的优先关系不多于一种。

综上, 该文法是算术优先文法。

编译原理		chapter1~5习题					
		,	a	^	()	#
,		▶		◀		▶	
a		▶					▶
^						▶	▶
(◀	◀	◀	◀	<u>◀</u>	
)							▶
#		▶	◀	◀	◀	<u>◀</u>	

输入串(a,(a,a))的算符优先过程。 问题：没有依据最左素短语进行规约

步骤	句型	优先关系	最左素短语	规约符号
1	#(a,(a,a))#	# < (<u>◀a▶</u> , < (◀a▶ , <a▶) >) > #	a	S
2	##(S,(a,a))#	# < (◀ , < (<u>◀a▶</u> , <a▶) >) > #	a	S
3	##(S,(S,a))#	# < (◀ , < (◀ , <u>◀a▶</u>) >) > #	a	S
4	##(S,(S,S))#	# < (◀ , < (◀ , <u>▶</u>) >) > #	S,S	T
5	##(S,(T))#	# < (◀ , < (<u>◀▶</u>) >) > #	(T)	S
6	##(S,S)#	# < (<u>◀ , ▶</u>) > #	S,S	T
7	##(T)#	# < (<u>◀▶</u>) > #	(T)	S
8	##S#			确认!

编译原理

chapter1~5习题

P134-5考虑文法 $S \rightarrow AS|b$ $A \rightarrow SA|a$

- 1、列出这个文法的所有LR(0)项目
- 2、构造这个文法的LR(0)项目集规范族及识别或前缀的DFA
- 3、这个文法是SLR的吗？若是，构造出它的SLR分析表
- 4、这个文法是LALR或LR(1)的吗

解答：1、

0. $S' \rightarrow \cdot S$	1. $S' \rightarrow S \cdot$	
2. $S \rightarrow \cdot AS$	3. $S \rightarrow A \cdot S$	4. $S \rightarrow AS \cdot$
5. $S \rightarrow \cdot b$	6. $S \rightarrow b \cdot$	
7. $A \rightarrow \cdot SA$	8. $A \rightarrow S \cdot A$	9. $A \rightarrow SA \cdot$
10. $S \rightarrow \cdot a$	11. $S \rightarrow a \cdot$	

编译原理

chapter1~5习题

P134-5考虑文法 $S \rightarrow AS|b$ $A \rightarrow SA|a$

1、列出这个文法的所有LR(0)项目

2、构造这个文法的LR(0)项目集规范族及识别或前缀的DFA

3、这个文法是SLR的吗？若是，构造出它的SLR分析表

4、这个文法是LALR或LR(1)的吗

解答：1、

The diagram illustrates the LR(0) DFA for the grammar $S \rightarrow AS|b$ and $A \rightarrow SA|a$. The states are numbered 0 through 11. The transitions are as follows:

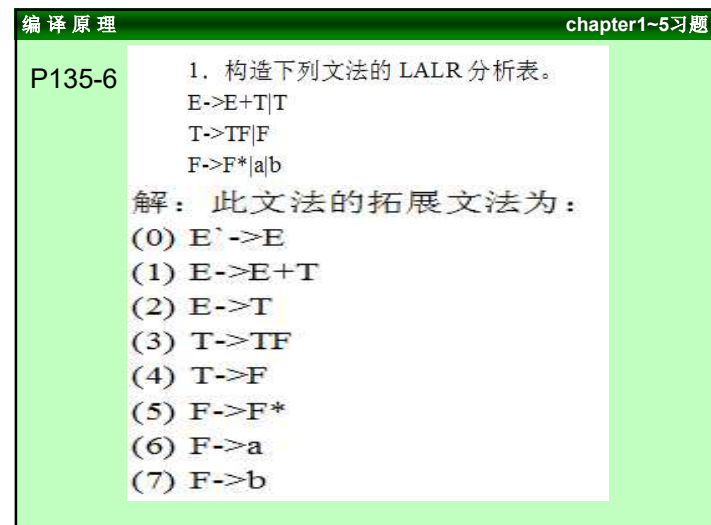
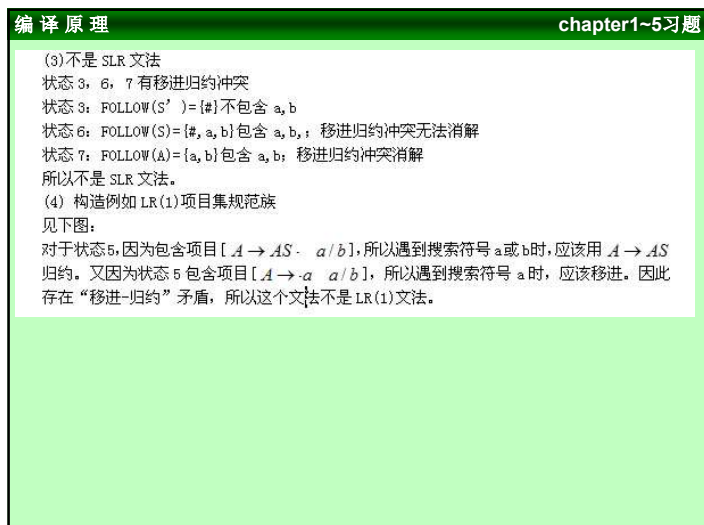
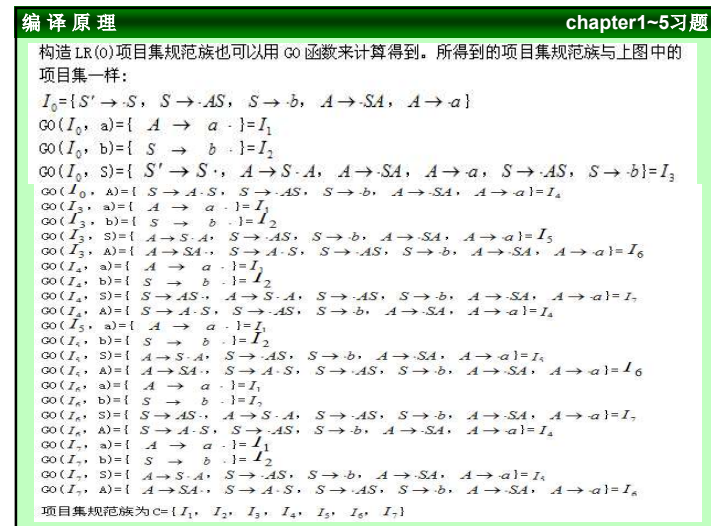
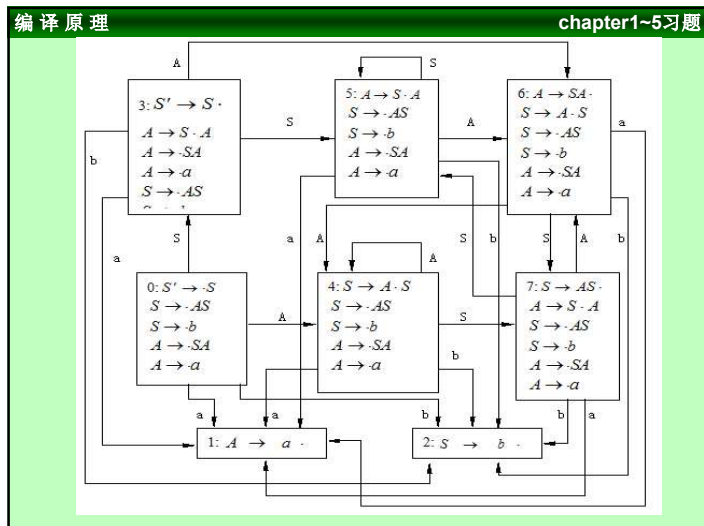
- State 0 (start state) transitions to State 1 on S , to State 2 on A , to State 5 on a , and to State 6 on b .
- State 1 transitions to State 7 on S and to State 8 on A .
- State 2 transitions to State 7 on S , to State 8 on A , to State 10 on a , and to State 3 on b .
- State 3 transitions to State 4 on S and to State 5 on a .
- State 4 transitions to State 5 on S and to State 6 on A .
- State 5 transitions to State 6 on S and to State 7 on A .
- State 6 transitions to State 7 on S and to State 8 on A .
- State 7 transitions to State 8 on S and to State 10 on A .
- State 8 transitions to State 9 on S and to State 11 on A .
- State 9 transitions to State 10 on S and to State 11 on A .
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编译原理

chapter1~5习题

确定化：

	S	A	a	b
{0, 2, 5, 7, 10}	{1, 2, 5, 7, 8, 10}	{2, 3, 5, 7, 10}	{11}	{6}
{1, 2, 5, 7, 8, 10}	{2, 5, 7, 8, 10}	{2, 3, 5, 7, 9, 10}	{11}	{6}
{2, 3, 5, 7, 10}	{2, 4, 5, 7, 8, 10}	{2, 3, 5, 7, 10}	{11}	{6}
{2, 5, 7, 8, 10}	{2, 5, 7, 8, 10}	{2, 3, 5, 7, 9, 10}	{11}	{6}
{2, 3, 5, 7, 9, 10}	{2, 4, 5, 7, 8, 10}	{2, 3, 5, 7, 10}	{11}	{6}
{2, 4, 5, 7, 8, 10}	{2, 5, 7, 8, 10}	{2, 3, 5, 7, 9, 10}	{11}	{6}



编译原理 chapter1~5习题

该文法的 LR(1)项目集规范族及其转换如下:

I₀:
 $E' \rightarrow \cdot E, \$$
 $E \rightarrow \cdot E+T, +/\$$
 $E \rightarrow \cdot T, +/\$$
 $T \rightarrow \cdot TF, a/b/+/\$$
 $T \rightarrow \cdot F, a/b/+/\$$
 $F \rightarrow \cdot F*, a/b/+*/\$$
 $F \rightarrow \cdot a, a/b/+*/\$$
 $F \rightarrow \cdot b, a/b/+*/\$$

I₁:
 $E' \rightarrow E \cdot, \$$
 $E \rightarrow E \cdot +T, +/\$$

I₂:
 $E \rightarrow T \cdot, +/\$$
 $T \rightarrow T \cdot F, a/b/+/\$$
 $F \rightarrow \cdot F*, a/b/+*/\$$
 $F \rightarrow \cdot a, a/b/+*/\$$
 $F \rightarrow \cdot b, a/b/+*/\$$

I₃:
 $T \rightarrow F \cdot, a/b/+/\$$
 $F \rightarrow F \cdot *, a/b/+*/\$$

I₄:
 $F \rightarrow a \cdot, a/b/+*/\$$

I₅:
 $F \rightarrow b \cdot, a/b/+*/\$$

I₆:
 $E \rightarrow E+ \cdot T, +/\$$
 $T \rightarrow \cdot TF, a/b/+/\$$
 $T \rightarrow \cdot F, a/b/+/\$$
 $F \rightarrow \cdot F*, a/b/+*/\$$
 $F \rightarrow \cdot a, a/b/+*/\$$
 $F \rightarrow \cdot b, a/b/+*/\$$

I₇:
 $T \rightarrow TF \cdot, a/b/+/\$$
 $F \rightarrow F \cdot *, a/b/+*/\$$

I₈:
 $E \rightarrow E+T \cdot, +/\$$
 $T \rightarrow T \cdot F, a/b/+/\$$
 $F \rightarrow \cdot F*, a/b/+*/\$$
 $F \rightarrow \cdot a, a/b/+*/\$$
 $F \rightarrow \cdot b, a/b/+*/\$$

I₉:
 $T \rightarrow T \cdot F, a/b/+/\$$
 $F \rightarrow \cdot F*, a/b/+*/\$$
 $F \rightarrow \cdot a, a/b/+*/\$$
 $F \rightarrow \cdot b, a/b/+*/\$$

编译原理 chapter1~5习题

根据以上可得出文法的 LR(1)预测分析表如下:

表达式文法的 LR(1)分析表

状态	动作					转移		
	+	*	a	b	\$	E	T	F
0			S4	S5	\$	1	2	3
1	S6				acc			
2	r2		S4	S5	r2			7
3	r4	S8	r4	r4	r4			
4	r6	r6	r6	r6	r6			
5	r7	r7	r7	r7	r7			
6			S4	S5			9	3
7	r3	S8	r3	r3	r3			
8	r5		r5	r5	r5			
9	r1		S4	S5	r1			7

没有需要合并的状态, 故 LALR 分析表同 LR(1) 分析表

编译原理 chapter1~5习题

P135-7证明下面文法是SLR(1)文法, 但不是LR(0)文法

$S \rightarrow A$ $A \rightarrow Ab|bBa$ $B \rightarrow aAc|aAb$

解: 文法G[S]:

0: $S \rightarrow A$ 1: $A \rightarrow Ab$ 2: $A \rightarrow bBa$
 3: $B \rightarrow aAc$ 4: $B \rightarrow a$ 5: $B \rightarrow aAb$

构造 LR(0)项目集规范族:

状态	项目集	转换函数
0	$S \rightarrow \cdot A$ $A \rightarrow \cdot Ab$ $A \rightarrow \cdot bBa$	$GO[0, A]=1$ $GO[0, A]=1$ $GO[0, b]=2$
1	$S \rightarrow A \cdot$ $A \rightarrow A \cdot b$	ACCEPT $GO[1, b]=3$
2	$A \rightarrow b \cdot Ba$ $B \rightarrow \cdot aAc$ $B \rightarrow \cdot a$ $B \rightarrow \cdot aAb$	$GO[2, B]=4$ $GO[2, a]=5$ $GO[2, a]=5$ $GO[2, a]=5$
3	$A \rightarrow Ab \cdot$	R1
4	$A \rightarrow bB \cdot a$	$GO[4, a]=6$

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5	$B \rightarrow a \cdot Ac$ $B \rightarrow a \cdot$ $B \rightarrow a \cdot Ab$ $A \rightarrow \cdot Ab$ $A \rightarrow \cdot bBa$	$GO[5, A]=7$ R4 $GO[5, A]=7$ $GO[5, A]=7$ $GO[5, b]=2$
6	$A \rightarrow bBa \cdot$	R2
7	$B \rightarrow aA \cdot c$ $B \rightarrow aA \cdot b$ $A \rightarrow A \cdot b$	$GO[7, c]=8$ $GO[7, b]=9$ $GO[7, b]=9$
8	$B \rightarrow aAc \cdot$	R3
9	$B \rightarrow aAb \cdot$ $A \rightarrow Ab \cdot$	R5 R1

状态 5 存在“归约-移进”冲突, 状态 9 存在“归约-归约”冲突, 因此该文法不是 LR(0) 文法。

状态 5:
 $FOLLOW(B) = \{a\}$, 因此, $FOLLOW(B) \cap \{b\} = \emptyset$

状态 9:
 $FOLLOW(B) = \{a\}$, $FOLLOW(A) = \{\#, b, c\}$, 因此 $FOLLOW(B) \cap FOLLOW(A) = \emptyset$

状态 5 和状态 9 的冲突均可用 SLR(1) 方法解决, 构造 SLR(1) 分析表如下:

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状态	ACTION				GOTO	
	a	b	c	#	A	B
0		S2			1	
1		S3		ACCEPT		
2	S5					4
3		R1	R1	R1		
4	S6					
5	R4	S2			7	
6		R2	R2	R2		
7		S9	S8			
8	R3					
9	R5	R1	R1	R1		

该 SLR(1) 分析表无重定义, 因此该文法是 SLR(1) 文法, 不是 LR(0) 文法。

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p135-8. 证明下面的文法是 LL(1) 的, 但不是 SLR(1) 的。

$S \rightarrow AaAb | BbBa$ $A \rightarrow \epsilon$ $B \rightarrow \epsilon$

解答:

(1) 首先该文法无左递归存在, 没有公共左因子。

其次: 对于 $S \rightarrow AaAb | BbBa$ $FIRST(AaAb) = \{a\}$ $FIRST(BbBa) = \{b\}$

$FIRST(AaAb) \cap FIRST(BbBa) = \emptyset$

所以该文法是 LL(1) 文法。

(2) 证明该文法不是 SLR 的。

文法的 LR(0) 项目集规范族为:

$I_0 = \{ S' \rightarrow \cdot S \quad S \rightarrow \cdot AaAb \quad S \rightarrow \cdot BbBa \quad A \rightarrow \cdot \quad B \rightarrow \cdot \}$

$I_1 = \{ S' \rightarrow S \cdot \}$

$I_2 = \{ S \rightarrow A \cdot aAb \}$

$I_3 = \{ S \rightarrow B \cdot bBa \}$

$I_4 = \{ S \rightarrow Aa \cdot Ab \quad A \rightarrow \cdot \}$

$I_5 = \{ S \rightarrow Bb \cdot Ba \quad B \rightarrow \cdot \}$

$I_6 = \{ S \rightarrow AaA \cdot b \}$

$I_7 = \{ S \rightarrow BbB \cdot a \}$

$I_8 = \{ S \rightarrow AaAb \cdot \}$

$I_9 = \{ S \rightarrow BbBa \cdot \}$

考察 I_0 : $FOLLOW(A) = \{a, b\}$ $FOLLOW(B) = \{a, b\}$

$FOLLOW(A) \cap FOLLOW(B) = \{a, b\}$

产生规约-规约冲突。

所以该文法不是 SLR(1) 文法。

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P135-9

证明下列文法是 LR(1) 文法, 但不是 LALR(1) 文法。

$S \rightarrow Aa | bAc | Bc | bBa$

$A \rightarrow d$

$B \rightarrow d$

■ 思路: 该文法产生的所有句子: da, bdc, dc, bda 。

LR(1) 分析器的移进-归约分析:

■ 面临 $d \rightarrow$ 移进, 然后面临 a 或 c 时, 分别将 d 归约成 A 或者 B , 再将 Aa 或 Bc 归约成 S ;

■ 面临 $b \rightarrow$ 移进, 接着面临 d 移进, 然后面临 a 或 c 时, 分别将 d 归约成 A 或者 B , 再将 bAc 或 bBa 归约成 S

因此该文法是 LR(1) 的

1、构造该文法的 SLR(1) 语法分析表

① 构造增广文法

$S' \rightarrow S$

$S \rightarrow Aa$

$S \rightarrow bAc$

$S \rightarrow dc$

$S \rightarrow bda$

$A \rightarrow d$

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② 构造 LR(0) 项集族

I_0 $S' \rightarrow \cdot S$ $S \rightarrow \cdot Aa$ $S \rightarrow \cdot bAc$ $S \rightarrow \cdot dc$ $S \rightarrow \cdot bda$ $A \rightarrow \cdot d$	I_1 $S' \rightarrow S \cdot$	I_2 $S \rightarrow A \cdot a$	I_5 $S \rightarrow Aa \cdot$	I_8 $S \rightarrow dc \cdot$
	I_3 $S \rightarrow b \cdot Ac$ $S \rightarrow b \cdot da$ $A \rightarrow \cdot d$	I_4 $S \rightarrow d \cdot c$ $A \rightarrow d \cdot$	I_6 $S \rightarrow bA \cdot c$	I_9 $S \rightarrow bAc \cdot$
			I_7 $S \rightarrow bd \cdot a$ $A \rightarrow d \cdot$	I_{10} $S \rightarrow bda \cdot$

③ GOTO 函数

$GOTO(I_0, S) = I_1$ $GOTO(I_0, A) = I_2$ $GOTO(I_0, b) = I_3$ $GOTO(I_0, d) = I_4$

$GOTO(I_1, \$) = acc$ $GOTO(I_2, a) = I_5$ $GOTO(I_3, A) = I_6$ $GOTO(I_3, d) = I_7$

$GOTO(I_4, c) = I_8$ $GOTO(I_6, c) = I_9$ $GOTO(I_7, a) = I_{10}$

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④ 构建 SLR 语法分析表如下 (FOLLOW(A) = {a, c})

状态	ACTION					GOTO	
	a	b	c	d	\$	S	A
0		S3		S4		1	2
1					acc		
2	S5						
3				S7			6
4	R5		S8 R5				
5					R1		
6			S9				
7	S10 | R5		R5				
8					R3		
9					R2		
10					R4		

可以看到在图中存在二义性的条目，故该文法不是 SLR(1) 文法

编译原理 chapter1~5习题

2、构造该文法的 LALR(1) 语法分析表

① 构造该增广文法的 LR(1) 项集族如下

I0 S' → . S, \$ S → . Aa, \$ S → . bAc, \$ S → . dc, \$ A → . d, a	I1 S' → S. , \$ I2 S → A. a, \$	I3 S → b. Ac, \$ S → b. da, \$ A → . d, c I4 S → d. c, \$ A → d. , \$	I5 S → Aa. , \$ I6 S → bA. c, \$	I7 S → bd. a. , \$ A → d. , c I8 S → dc. , \$	I9 S → bAc. , \$ I10 S → bda. , \$
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② 项集合并：没有可以合并的项集

③ GOTO 函数

GOTO(I0, S) = I1 GOTO(I0, A) = I2 GOTO(I0, b) = I3 GOTO(I0, d) = I4
 GOTO(I1, \$) = acc GOTO(I2, a) = I5 GOTO(I3, A) = I6 GOTO(I3, d) = I7

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GOTO(I4, c) = I8 GOTO(I6, c) = I9 GOTO(I7, a) = I10

④ 构造 LALR(1) 分析表如下

状态	ACTION					GOTO	
	a	b	c	d	\$	S	A
0		S3		S4		1	2
1					acc		
2	S5						
3				S7			6
4	R5		S8		R5		
5					R1		
6			S9				
7	S10		R5				
8					R3		
9					R2		
10					R4		

可见该分析表中不存在二义性的条目，故该文法是 LALR(1) 文法