

10/05/2012

~~newism~~

~~Assistance~~

[A horizontal blue ink line with a wavy, scribbled pattern.]

③ $S \rightarrow CC$ $C \rightarrow zC \mid d$ LALR

$$② E \rightarrow_w E \downarrow E \vdash id := E \mid E + E \mid id$$

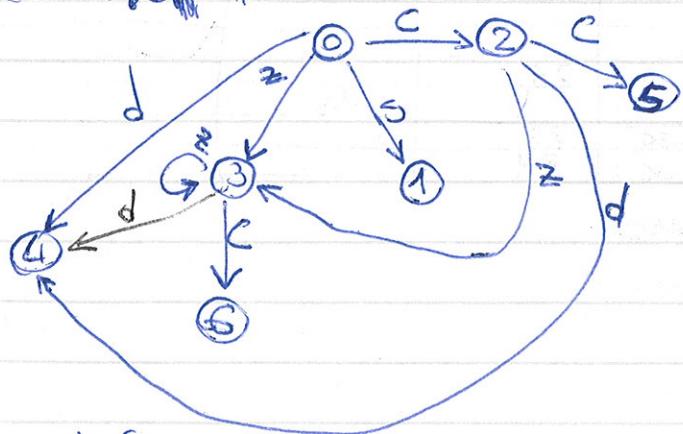
Show the Schrödinger table

Show the SIR table
Can you solve the conflicts in the SIR table so to get the conventional meaning of operators and command

$$\begin{array}{l} \text{① } S \rightarrow CC \\ C \rightarrow zC|d \end{array} \Rightarrow \begin{array}{l} \text{(1) } S \rightarrow CC \\ \text{(2) } C \rightarrow zC \\ \text{(3) } C \rightarrow d \end{array}$$

$$I = S \rightarrow S, \quad \$$$

$$I_2 = \text{sgn}(I_0, C) \\ S \rightarrow C.C \\ \{ C \rightarrow \text{ZC} \\ C \rightarrow d \}$$



$$I_5 = \lim_{S \rightarrow CC} (I_2, C)$$

Z	d	\$	C	S
0 S3	S4		2	1
1		acc		
2 S3	S4		5	
3 S8	S9		6	
4 C->d	C->d	C->d		
5		S->C		
6 C->d	C->d	C->d		

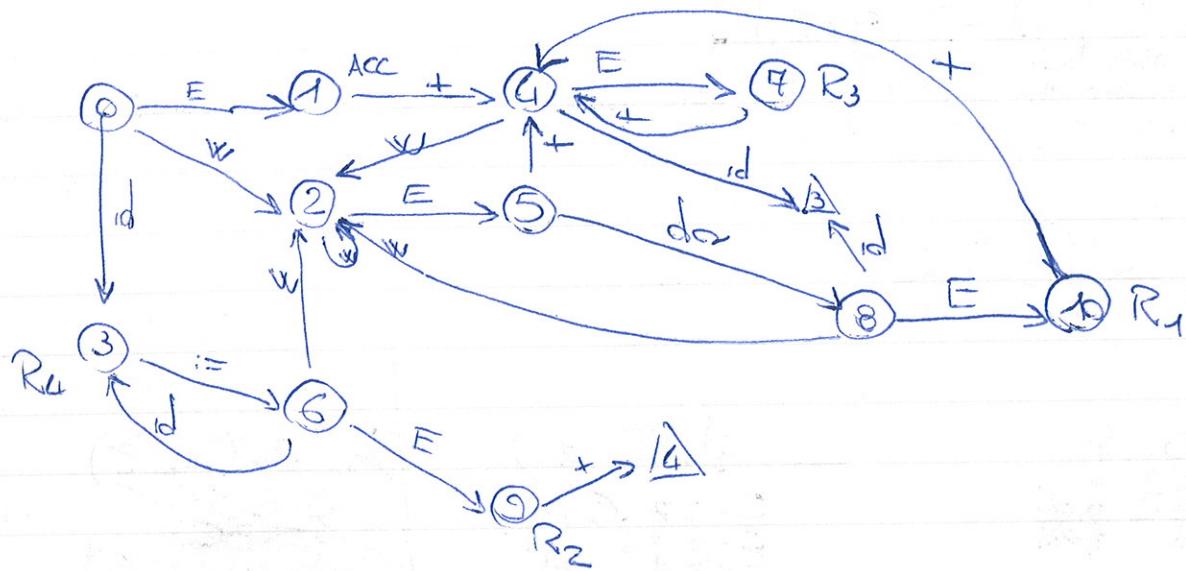
$$I_6 = \text{gob}(I_3, c) \\ c \rightarrow zC_0 \quad \text{z, } \#$$

②

$$\begin{array}{l}
 E \rightarrow w E \quad |w| \\
 E \rightarrow id := E \\
 E \rightarrow E + E \\
 E \rightarrow \text{id}
 \end{array}
 \quad R_1 \\
 \quad R_2 \\
 \quad R_3 \\
 \quad R_4$$

Forward(E)

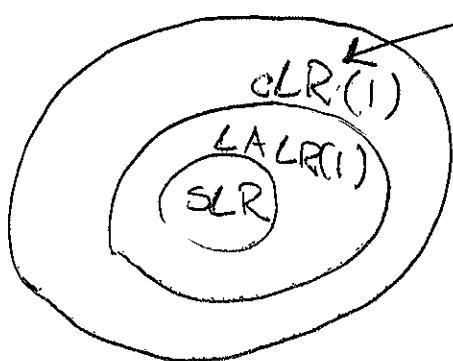
\$ dor +



	w	dor	id	=	+	\$	E	
0	A2		A3				1	
1				A4	ACC			
2	A2		A3					
3		R4	A6		R4	R4		
4	A2		A3			A6		7
5		A8	A3					
6			A3					9
7		R3		R3	S4	R3		
8	A2		A3					10
9		R2		R2	S4	R2		
10		R1		R1	S4	R1		

9/05/2012

compositional LR Grammar



$$S \rightarrow aAd \mid bBd \mid aBe \mid bAe$$

$$A \rightarrow c$$

$$B \rightarrow c$$

$$\begin{aligned} I_0 &= S' \rightarrow S \quad \$ \\ &\quad S \rightarrow aAd \quad \$ \\ &\quad S \rightarrow bBd \quad \$ \\ &\quad S \rightarrow aBe \quad \$ \\ &\quad S \rightarrow bAe \quad \$ \end{aligned}$$

$$\begin{aligned} I_1 &= \text{goto}(I_0, S) \\ &\quad S' \rightarrow S \quad \$ \end{aligned}$$

$$\begin{aligned} I_2 &= \text{goto}(I_0, a) \\ &\quad S \rightarrow a \cdot Ad \quad \$ \\ &\quad S \rightarrow a \cdot Be \quad \$ \\ &\quad A \rightarrow c \quad d \\ &\quad B \rightarrow c \quad e \end{aligned}$$

$$\begin{aligned} I_3 &= \text{goto}(I_0, b) \\ &\quad S \rightarrow b \cdot Bd \quad \$ \\ &\quad S \rightarrow b \cdot Ae \quad \$ \\ &\quad B \rightarrow c \quad d \\ &\quad A \rightarrow c \quad e \end{aligned}$$

$$\begin{aligned} I_4 &= \text{goto}(I_2, A) \\ &\quad S \rightarrow a \cdot Ad \quad d ? \\ I_5 &= \text{goto}(I_2, B) \\ &\quad S \rightarrow a \cdot Be \quad e ? \end{aligned}$$

$$\begin{aligned} I_6 &= \text{goto}(I_2, c) \\ &\quad A \rightarrow c \cdot \quad d \\ &\quad B \rightarrow c \cdot \quad e \end{aligned}$$

$$\begin{aligned} I_7 &= \text{goto}(I_3, B) \\ &\quad S \rightarrow b \cdot Bd \quad \$ \end{aligned}$$

$$\begin{aligned} I_8 &= \text{goto}(I_3, A) \\ &\quad S \rightarrow b \cdot Ae \quad \$ \end{aligned}$$

$$\begin{aligned} I_9 &= \text{goto}(I_3, C) \\ &\quad B \rightarrow c \cdot \quad d \\ &\quad A \rightarrow c \cdot \quad e \end{aligned}$$

$$L(G) = \{acd, bcd, ace, bce\}$$

$$\begin{aligned} I_{10} &= \text{goto}(I_4, d) \\ &\quad S \rightarrow a \cdot Ad \end{aligned}$$

$$\begin{aligned} I_{11} &= \text{goto}(I_5, e) \\ &\quad S \rightarrow a \cdot Be \quad \$ \end{aligned}$$

$$\begin{aligned} I_{12} &= \text{goto}(I_7, d) \\ &\quad S \rightarrow b \cdot Bd \quad \$ \end{aligned}$$

$$\begin{aligned} I_{13} &= \text{goto}(I_8, e) \\ &\quad S \rightarrow b \cdot Ae \quad \$ \end{aligned}$$

$S \rightarrow M_a \mid b \quad M_c \mid d \alpha \mid b \alpha$

LALR(1)

SLR

$I_0 = S \rightarrow S \quad \$$
 $S \rightarrow M_a \quad \$$
 $S \rightarrow bM_c \quad \$$
 $S \rightarrow d\alpha \quad \$$
 $S \rightarrow b\alpha \quad \$$
 $M \rightarrow d \quad \$$

$I_1 = \text{gtr}(I_0, S)$
 $S \rightarrow S. \quad \$$
 $I_2 = \text{gtr}(I_0, M)$
 $S \rightarrow M.a \quad \$$

$I_3 = \text{gtr}(I_0, b)$
 $S \rightarrow b.M_c \quad \$$
 $S \rightarrow b.d\alpha \quad \$$
 $M \rightarrow d \quad c$

$I_4 = \text{gtr}(I_0, d)$
 $S \rightarrow d.c \quad \$$
 $M \rightarrow d. \quad c ?$

$I_5 = \text{gtr}(I_2, a)$
 $S \rightarrow M.a. \quad \$$

$I_6 = \text{gtr}(I_3, M)$
 $S \rightarrow bM.c \quad \$$

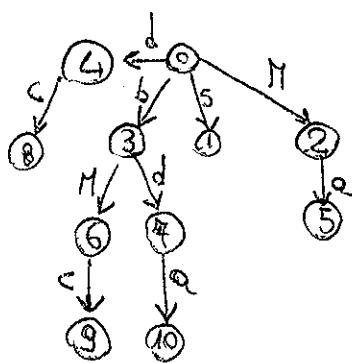
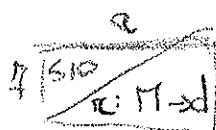
$I_8 = \text{gtr}(I_4, c)$
 $S \rightarrow d.c. \quad \$$

$I_7 = \text{gtr}(I_3, d)$
 $S \rightarrow b d.a \quad \$$
 $M \rightarrow d. \quad \$$

$I_{10} = \text{gtr}(I_4, a)$
 $S \rightarrow b \alpha. \quad \$$

$I_9 = \text{gtr}(I_6, c)$
 $S \rightarrow b M.c. \quad \$$

	FIRST	Follow
S	d, b	$\$$
M	d	c, a



4/07/2012

$a^m b^m a^{m+m}$

$a^m \overline{[b^m a^m]} a^m$

$S \rightarrow aSa \mid aBa$

$B \rightarrow ba \mid bBa$

regular
expression

$a (a \mid ba)^+ b$

NFA



DFA

Esercizio sulla Left-Recursion

$\text{exp} \rightarrow \text{exp addop term Hterm}$

$\text{addop} \rightarrow + | -$

$\text{term} \rightarrow \text{term mulop factor} | \text{factor}$

$\text{mulop} \rightarrow *$

$\text{factor} \rightarrow (\text{exp}) | \text{number}$

$\text{exp} = A_1$

$\text{addop} = A_2$

$\text{term} = A_3$

$\text{mulop} = A_4$

$\text{factor} = A_5$

change in

$A_1 \rightarrow A_1 A_2 A_3 | A_3$

$A_2 \rightarrow + | -$

$A_3 \rightarrow A_3 A_4 A_5 | A_5$

$A_4 \rightarrow *$

$A_5 \rightarrow (\text{A}_1) | \text{number}$

$(i=1, j=1) \quad \underline{A_1 \rightarrow A_3 A'_1}$
 $\quad \quad \quad | \quad \underline{A'_1 \rightarrow A_2 A_3 A'_1 | \epsilon}$

$(i=1, j=2) \quad \text{NO}$

$(i=1, j=3) \quad \underline{A_1 \rightarrow A_3 A_4 A_5 A'_1} \quad | \quad A_5 A'_1$

$(i=1, j=4) \quad \text{NO}$

$(i=1, j=5) \quad \underline{A_1 \rightarrow A_3 A_4 A_5 A'_1} \quad | \quad (\text{A}_1) A'_1 \quad | \quad \text{number } A'_1$

$(i=2, j=1) \quad \text{NO}$

$(i=2, j=2) \quad \text{NO}$

$(i=2, j=3) \quad \text{NO}$

$(i=2, j=4) \quad \text{NO}$

$(i=2, j=5) \quad \text{NO}$

$(i=3, j=1)$ NO

$(i=3, j=2)$ NO

$(i=3, j=3)$ immediate BTZ $A_3 \rightarrow A_3 A_4 A_5 | A_5$

recursion

↓ elimination of immediate BTZ recursion

$$\boxed{A_3 \rightarrow A_5 A_3'}$$

$$\boxed{A_3' \rightarrow A_4 A_5 A_3' | \epsilon}$$

$(i=3, j=4)$ NO

$(i=3, j=5)$ $| A_3 \rightarrow (A_1) A_3' | \text{number } A_3'$

$(i=4, j=1)$ NO

$(i=4, j=2)$ NO

$(i=4, j=3)$ NO

$(i=4, j=4)$ NO

$(i=4, j=5)$ NO

$(i=5, j=1)$ NO

$(i=5, j=2)$ NO

$(i=5, j=3)$ NO

$(i=5, j=4)$ NO

$(i=5, j=5)$ NO

$$A_1 \rightarrow A_3 A_4 A_5 | (A_1) A_1' | \text{number } A_1'$$

$$A_1' \rightarrow A_2 A_3 A_1' | \epsilon$$

$$A_2 \rightarrow + | -$$

$$A_3 \rightarrow (A_1) A_3' | \text{number } A_3'$$

$$A_3' \rightarrow A_4 A_5 A_3' | \epsilon$$

$$A_4 \rightarrow *$$

$$A_5 \rightarrow (A_1) | \text{number}$$

$\text{exp} \rightarrow \text{term mulop factor} | (\text{exp}) \text{exp}' | \text{number exp}'$

$\text{exp}' \rightarrow \text{addop term exp}' | \epsilon$

$\text{addop} \rightarrow + | -$

$\text{term} \rightarrow (\text{exp}) \text{term}' | \text{number term}'$

$\text{term}' \rightarrow \text{mulop factor term}' | \epsilon$

$\text{mulop} \rightarrow *$

$\text{factor} \rightarrow (\text{exp}) | \text{number}$

Eliminazione della Left recursion

$$\begin{aligned} A &\rightarrow Bxy \mid x \\ B &\rightarrow CD \\ C &\rightarrow A \mid c \\ D &\rightarrow d \end{aligned}$$

$$\begin{aligned} A_1 &\rightarrow A_2xy \mid x \\ A_2 &\rightarrow A_3A_4 \\ A_3 &\rightarrow A_1 \mid c \\ A_4 &\rightarrow d \end{aligned}$$

$$\begin{aligned} A_1 &= A \\ A_2 &= B \\ A_3 &= C \\ A_4 &= D \end{aligned}$$

$(i=1, j=1)$ NO

$(i=1, j=2)$ $A_1 \rightarrow A_3A_4xy \mid x$

$(i=1, j=3)$ $A_1 \rightarrow \underline{A_1A_4xy} \mid cA_4xy \mid x$

direct
left-recursion

$$\boxed{\begin{array}{l} A_1 \rightarrow cA_4xy A'_1 \mid x A'_1 \\ A'_1 \rightarrow A_4xy A'_1 \mid \epsilon \end{array}}$$

$(i=1, j=4)$ NO

$(i=2, j=1)$ NO

$(i=2, j=2)$ NO

$(i=2, j=3)$ $\boxed{A_2 \rightarrow A_1A_4 \mid cA_4}$

$(i=2, j=4)$ NO

$(i=3, j=1)$ $\boxed{A_3 \rightarrow cA_4xy A'_1 \mid x A'_1 \mid c}$

$(i=3, j=2)$ NO

$(i=3, j=3)$ NO

$(i=3, j=4)$ NO

- $(i=4, j=1)$ NO
- $(i=4, j=2)$ NO
- $(i=4, j=3)$ NO
- $(i=4, j=4)$ NO

$$\begin{aligned}
 A_1 &\rightarrow cA_4 \times y A'_1 | \times A'_1 \\
 A'_1 &\rightarrow A_4 \times y A'_1 | \epsilon \\
 A_2 &\rightarrow A_1 A_4 | c A_4 \\
 A_3 &\rightarrow cA_4 \times y A'_1 | \times A'_1 | c \\
 A_4 &\rightarrow d
 \end{aligned}$$

$$\begin{aligned}
 A &\rightarrow cD \times y A' | \times A' \\
 A' &\rightarrow D \times y A' | \epsilon \\
 B &\rightarrow AD | cD \\
 C &\rightarrow cD \times y A' | \times A' | c \\
 D &\rightarrow d
 \end{aligned}$$

corretto

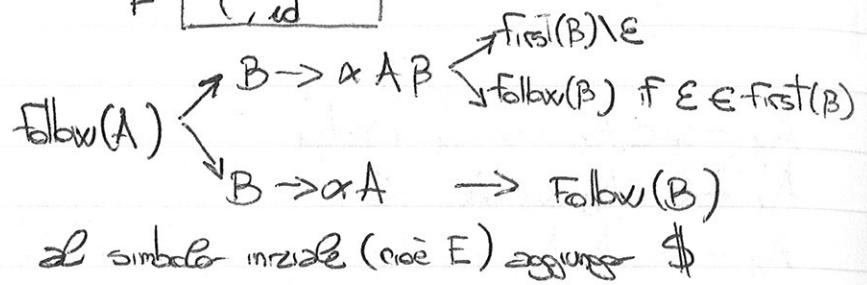
Nonrecursive Reductive Parsing (TOP-DOWN PARSING)

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

FOLLOW

$$\begin{aligned}
 E &= \boxed{\$, id} \\
 E' &= \text{Follow}(E) = \boxed{\$, id} \\
 T &= +, \text{Follow}(E') = \boxed{+, \$, id} \\
 T' &= \text{Follow}(T^*) = \boxed{+, \$, id} \\
 F &= *, \text{Follow}(T') = \boxed{*+, \$, id}
 \end{aligned}$$

FIRST	
E	(, id
E'	+, ε
T	(, id
T'	*, ε
F	(, id



	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	$F \rightarrow id$			$F \rightarrow (E)$		

HATCHED

-ed + * ed

STACK

INPUT

ACTION
 $t E \rightarrow TE'$
 $t T \rightarrow FT'$
 $t F \rightarrow id$
 ch id
 $t T \rightarrow E$
 $E \rightarrow +TE'$
 ch +
 $T T \rightarrow FT'$
 $t F \rightarrow id$
 ch id
 $T \rightarrow *FT'$
 ch *
 $t F \rightarrow id$
 ch id
 $t T \rightarrow E$
 $t E' \rightarrow E$
 next

BOTTOM-UP PARSING

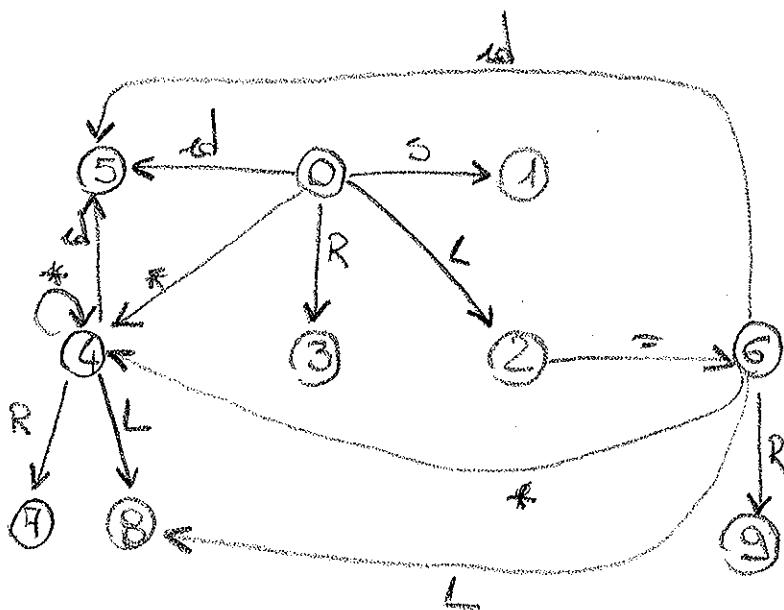
$$S \rightarrow L=R \mid R \\ L \rightarrow *R \mid id \\ R \rightarrow L \\ \Rightarrow \begin{array}{l} (1) S \rightarrow L=R \\ (2) S \rightarrow R \\ (3) L \rightarrow *R \\ (4) L \rightarrow id \\ (5) R \rightarrow L \end{array}$$

SLR (LR(0)) ?

$$I_0 = S \rightarrow S \\ S \rightarrow L=R \\ S \rightarrow R \\ L \rightarrow *R \\ L \rightarrow id \\ R \rightarrow L$$

$$I_1 = \text{gb}(I_0, S) \quad I_2 = \text{gb}(I_0, L) \quad I_3 = \text{gb}(I_0, R) \\ S \rightarrow S. \quad S \rightarrow L=R. \quad S \rightarrow R. \\ I_4 = \text{gb}(I_0, *) \quad I_5 = \text{gb}(I_0, id) \quad I_6 = \text{gb}(I_2, =) \quad I_7 = \text{gb}(I_4, R) \\ L \rightarrow *R. \quad L \rightarrow id. \quad S \rightarrow L=R. \quad L \rightarrow *R. \\ R \rightarrow L \\ R \rightarrow L \\ L \rightarrow *R \\ L \rightarrow id$$

$$I_8 = \text{gb}(I_4, L) \quad I_9 = \text{gb}(I_0, R) \\ R \rightarrow L. \quad S \rightarrow L=R.$$



$$\begin{aligned} \text{gb}(I_4, *) &= I_4 \\ \text{gb}(I_4, id) &= I_5 \\ \text{gb}(I_6, *) &= I_4 \\ \text{gb}(I_6, id) &= I_5 \\ \text{gb}(I_6, L) &= I_8 \end{aligned}$$

	FIRST	FOLLOW
S	*	\$
R	*	=
L	*	=

	=	*	id	\$	S	L	R
0		s ₄	s ₅	accept	s ₁	s ₂	s ₃
1				s ₅			
2							
3							
4							
5							
6							
7							
8							
9							

La grammatica non è SLR perché c'è un conflitto
nella tabella nella posizione [2, =]

CLR

$$S \rightarrow L = R | R \\ L \rightarrow *R | id \\ R \rightarrow L$$

(1) $S \rightarrow L = R$
 (2) $S \rightarrow R$
 (3) $L \rightarrow *R$
 (4) $L \rightarrow id$
 (5) $R \rightarrow L$

LR(1) (CLR - Canonical LR)
 Es parte de parsing d.
 Tipo LR(1) cioè con
 lookahead = 1

$$I_0 = S' \rightarrow S. \quad \$ \\ S \rightarrow L = R. \quad \$ \\ S \rightarrow R. \quad \$ \\ L \rightarrow *R. \quad !=\$ \\ L \rightarrow id. \quad !=\$ \\ R \rightarrow L. \quad \$$$

$$I_4 = \text{goto}(I_0, *) \\ L \rightarrow *R. \quad !=\$ \\ R \rightarrow L. \quad !=\$ \\ L \rightarrow *R. \quad !=\$ \\ L \rightarrow id. \quad !=\$$$

$$I_8 = \text{goto}(I_4, L) \\ R \rightarrow L. \quad !=\$$$

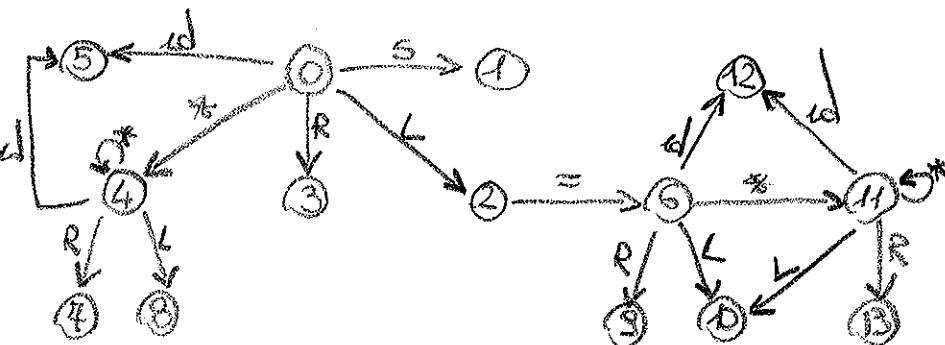
$$I_{11} = \text{goto}(I_8, *) \\ L \rightarrow *R. \quad \$ \\ R \rightarrow L. \quad \$ \\ L \rightarrow *R. \quad \$ \\ L \rightarrow id. \quad \$$$

$$I_1 = \text{goto}(I_0, S) \\ S' \rightarrow S. \quad \$ \\ I_2 = \text{goto}(I_0, L) \\ S \rightarrow L. = R. \quad \$ \\ R \rightarrow L. \quad \$ \\ I_3 = \text{goto}(I_0, R) \\ S \rightarrow R. \quad \$$$

$$I_5 = \text{goto}(I_0, id) \\ L \rightarrow id. \quad !=\$ \\ I_6 = \text{goto}(I_2, =) \\ S \rightarrow L = R. \quad \$ \\ R \rightarrow L. \quad \$ \\ L \rightarrow *R. \quad \$ \\ L \rightarrow id. \quad \$ \\ I_7 = \text{goto}(I_2, R) \\ S \rightarrow L = R. \quad \$ \\ R \rightarrow L. \quad \$$$

$$I_{10} = \text{goto}(I_6, L) \\ R \rightarrow L. \quad \$ \\ I_{12} = \text{goto}(I_6, id) \\ L \rightarrow id. \quad \$ \\ I_{13} = \text{goto}(I_{11}, R) \\ L \rightarrow *R. \quad \$$$

$$\text{goto}(I_4, *) = I_1 \\ \text{goto}(I_4, id) = I_5 \\ \text{goto}(I_{11}, L) = I_{10} \\ \text{goto}(I_{11}, *) = I_{11} \\ \text{goto}(I_{11}, id) = I_{12}$$



	=	*	ed	\$	S	L	R
0		s_4	s_5		g_1	g_2	g_3
1	s_6			accept			
2				r_5			
3				r_2			
4		s_4	s_5			g_8	g_4
5	r_4			r_4			
6		s_{11}	s_{12}			g_{10}	g_9
7	r_3			r_3			
8	r_5			r_5			
9				r_1			
10				r_5			
11		s_{11}	s_{12}			g_{10}	g_{13}
12				r_4			
13				r_3			

Stack	Symbol	Input	Action
0		$ed = ed \$$	Shift 5
0, 5	ed	$= ed \$$	reduce 4 $L \rightarrow ed$
0, 2	L	$= ed \$$	shift 6
0, 2, 6	$L =$	$ed \$$	shift 12
0, 2, 6, 12	$L = ed$	$\$$	reduce 4 $L \rightarrow ed$
0, 2, 6, 10	$L = L$	$\$$	reduce 5 $R \rightarrow L$
0, 2, 6, 10, 9	$L = R$	$\$$	reduce 1 $S \rightarrow L = R$
0, 1	S	$\$$	accept

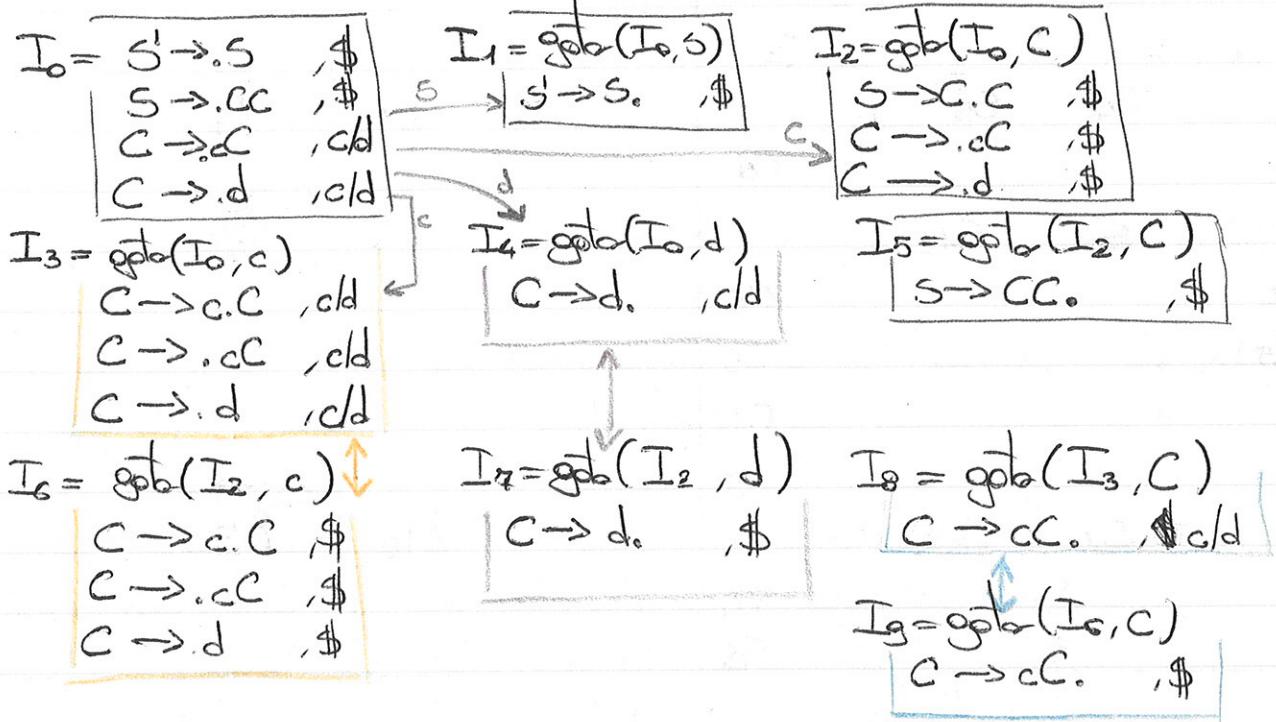
Using alternatives

0	$ed = ed \$$	shift 5
0, ed 5	$= ed \$$	reduce $L \rightarrow ed$
0, L 2	$\$$	shift 6
0, L 2 = 6	$\$$	shift 12
0, L 2 = 6, id 12	$\$$	reduce $L \rightarrow ed$
0, L 2 = 6, L 10	$\$$	reduce $R \rightarrow L$
0, L 2 = 6, L 10, 9	$\$$	reduce $S \rightarrow L = R$
0, S 1	$\$$	accept

$S' \rightarrow S$
 $S \rightarrow CC$
 $C \rightarrow cC \mid d$

(1) $S \rightarrow CC$
 (2) $C \rightarrow cC$
 (3) $C \rightarrow d$

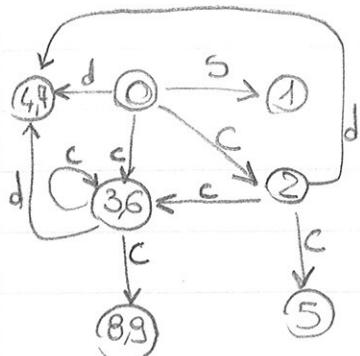
LALR



Per LALR unisco i set con stesso core e diverso lookahead quindi:

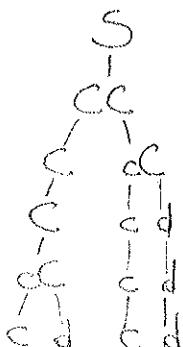
$I_0 = S' \rightarrow .S \quad \$$	$I_1 = S \rightarrow .CC \quad \$$	$I_2 = S \rightarrow C.C \quad \$$	$I_{3,6} = S \rightarrow CC. \quad \$$
$S \rightarrow .CC \quad \$$	$S \rightarrow .S \quad \$$	$S \rightarrow C.C \quad \$$	$C \rightarrow .cC \quad ,c/d/\$$
$C \rightarrow .cC \quad ,c/d$	$C \rightarrow .CC \quad ,\$$	$C \rightarrow .CC \quad ,\$$	$C \rightarrow .cC \quad ,c/d/\$$
$C \rightarrow .d \quad ,\$$	$C \rightarrow .d \quad ,c/d/\$$	$C \rightarrow .d \quad ,\$$	$C \rightarrow .d \quad ,c/d/\$$

$I_{4,7} = C \rightarrow .d \quad ,c/d/\$$	$I_5 = S \rightarrow .CC \quad \$$	$I_{8,9} = S \rightarrow CC. \quad ,c/d/\$$
--	------------------------------------	---



STAT1	C	d	\$		S	C
0	$s_{3,6}$	$s_{4,7}$		accept	g_1	g_2
1						
2	$s_{3,6}$	$s_{4,7}$				g_5
3,6	$s_{3,6}$	$s_{4,7}$				$g_{6,9}$
4,7	r_3	r_3	r_3			
5			r_1			
8,9	r_2	r_2	r_2			

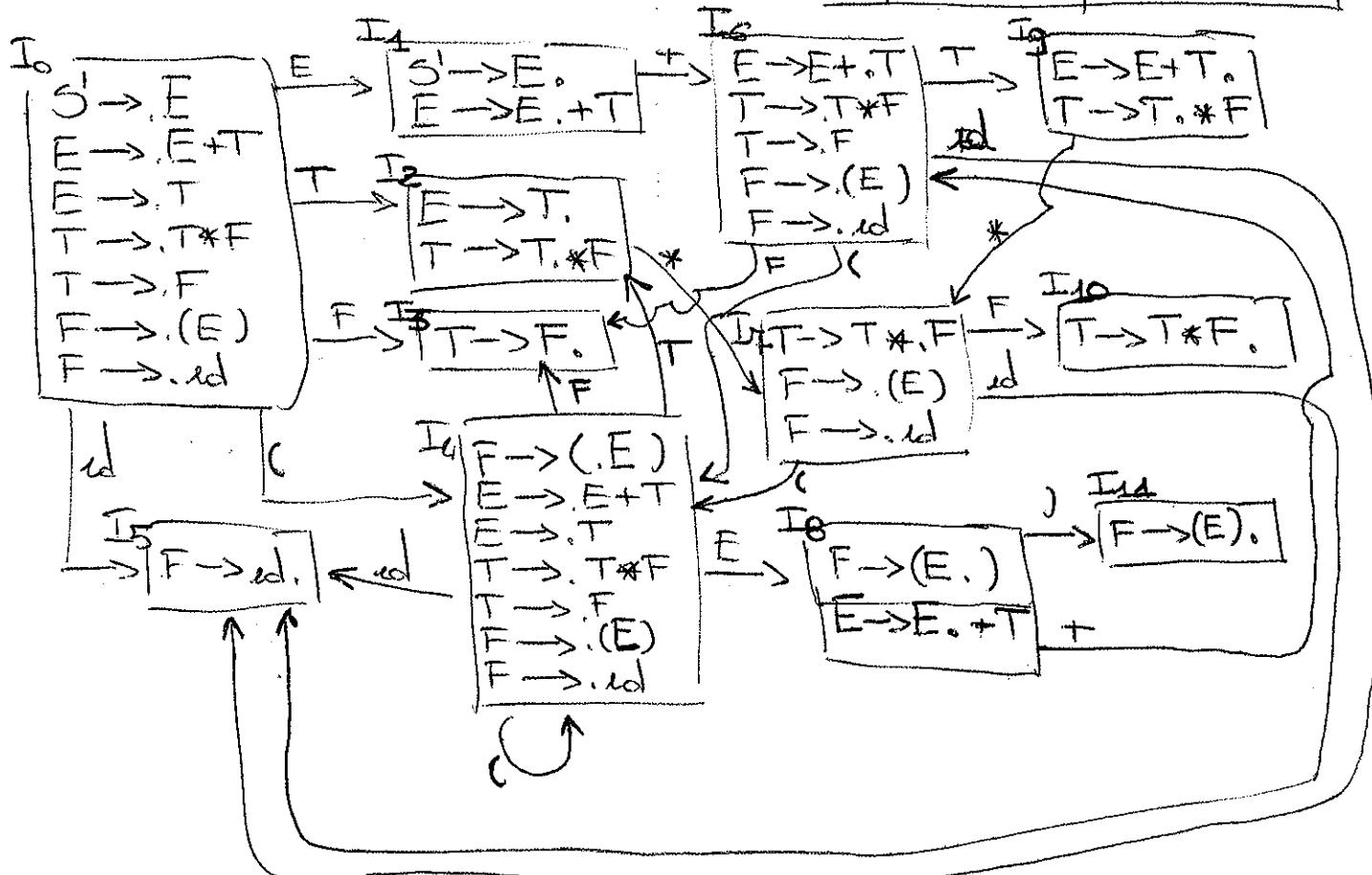
Stack	Symbol	Input	Actions
0		c d c d \$	shift 3/6
0, 3/6	c	d c d \$	shift 4/7
0, 3/6, 4/7	cd	c d \$	reduce 3 C → d
0, 3/6, 8/9	cC	c d \$	reduce 2 C → cC
0, 2	c	c d \$	shift 3/6
0, 2, 3/6	cc	d \$	shift 4/7
0, 2, 3/6, 4/7	ccd	\$	reduce 3 C → d
0, 2, 3/6, 8/9	ccC	\$	reduce 2 C → cC
0, 2, 5	CC	\$	reduce 1 S → CC
0, 1	S	\$	accept



SLR

$$\begin{array}{l}
 E \rightarrow E + T \mid T \\
 T \rightarrow T * F \mid F \\
 F \rightarrow (E) \mid id
 \end{array} \Rightarrow
 \begin{array}{l}
 (1) E \rightarrow E + T \\
 (2) E \rightarrow T \\
 (3) T \rightarrow T * F \\
 (4) T \rightarrow F \\
 (5) F \rightarrow (E) \\
 (6) F \rightarrow id
 \end{array}$$

	FIRST	FOLLOW
E	(id	\$ +)
T	(id	\$ +) *
F	(id	\$ +) *



	id	()	+	*	\$	E	T	F
0	s_5	s_4					s_1	s_2	s_3
1						ACC			
2				s_6					
3				$\gamma: E \rightarrow T$	$\gamma: E \rightarrow T$	s_7			
4	s_5	s_4							
5				$\gamma: T \rightarrow F$	$\gamma: T \rightarrow F$	$\gamma: T \rightarrow F$			
6	s_5	s_4							
7	s_5	s_4							
8			s_{11}	s_8					
9			$\gamma: E \rightarrow E + T$	$\gamma: E \rightarrow E + T$		$\gamma: E \rightarrow E + T$			
10			$\gamma: T \rightarrow T * F$	$\gamma: T \rightarrow T * F$		$\gamma: T \rightarrow T * F$			
11			$\gamma: F \rightarrow (E)$	$\gamma: F \rightarrow (E)$		$\gamma: F \rightarrow (E)$			

quind G 15 SLR

LALR

G:

$$S \rightarrow AB \mid ac \mid xAc$$

$$A \rightarrow a$$

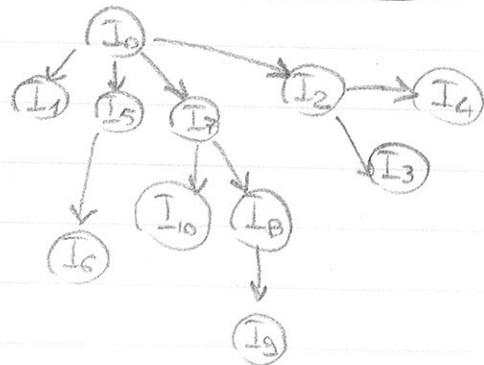
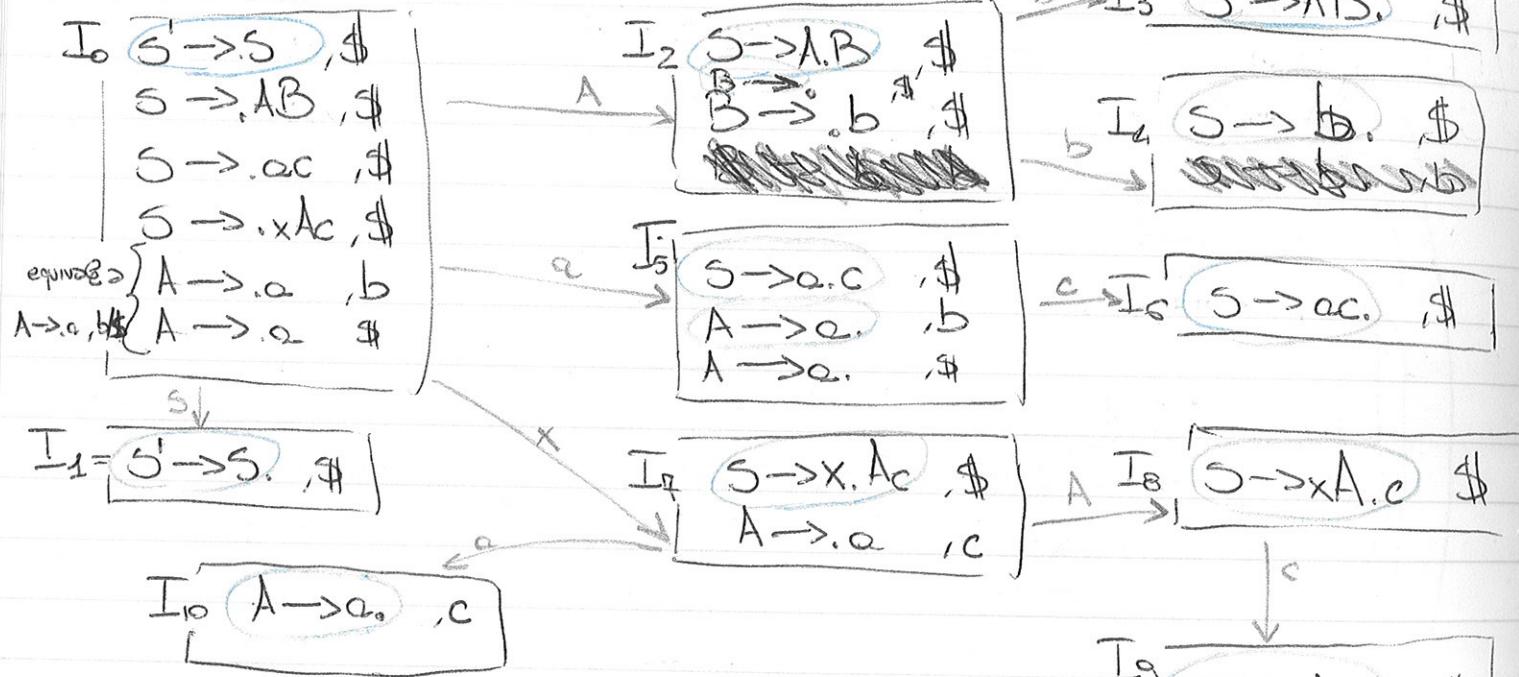
$$B \rightarrow b \mid \epsilon$$

- (1) $S \rightarrow AB$
 $\Rightarrow (2) S \rightarrow ac$
- (3) $S \rightarrow xAc$
- (4) $A \rightarrow a$
- (5) $B \rightarrow b$
- (6) $B \rightarrow \epsilon$

G is NOT SLR because

$$M[S, c] = S_a, \text{ reduce } "A \rightarrow a"$$

	FIRST	Follow
S	a, x	\$
A	a	c, b, \$
B	b, ϵ	\$



- 01 $S' \rightarrow S, \$$
 11 $S' \rightarrow S, \$$
 21 $S \rightarrow AB, \$$
 22 $B \rightarrow .$
 31 $S \rightarrow AB, \$$
 41 $S \rightarrow b, \$$
 51 $S \rightarrow ac, \$$
 52 $A \rightarrow a, \$$

- 61 $S \rightarrow ac, \$$
 71 $S \rightarrow xAc, \$$
 81 $S \rightarrow xA.c, \$$
 91 $S \rightarrow xAc, \$$
 101 $A \rightarrow a, \$$

Calcolo le closure di ogni LR(0)-item e segna l'algoritmo di calcolo del propagation graph.

01	$S' \rightarrow S, \$$
	$S \rightarrow AB, \$$
	$S \rightarrow ac, \$$
	$S \rightarrow xAc, \$$
	$A \rightarrow a, \$$
	$A \rightarrow a, b$

11	$S' \rightarrow S, \$$
	$S \rightarrow AB, \$$
	$B \rightarrow b, \$$
	$B \rightarrow ., \$$

22	$B \rightarrow ., \$$
	$S \rightarrow AB, \$$
	$41 S \rightarrow b, \$$
	$51 S \rightarrow ac, \$$

52	$A \rightarrow a, \$$
	$61 S \rightarrow ac, \$$
	$71 S \rightarrow xAc, \$$
	$A \rightarrow a, c$

81 S → xA.c b

91 S → xAc. b

101 A → a. , c

- Proposition

from to

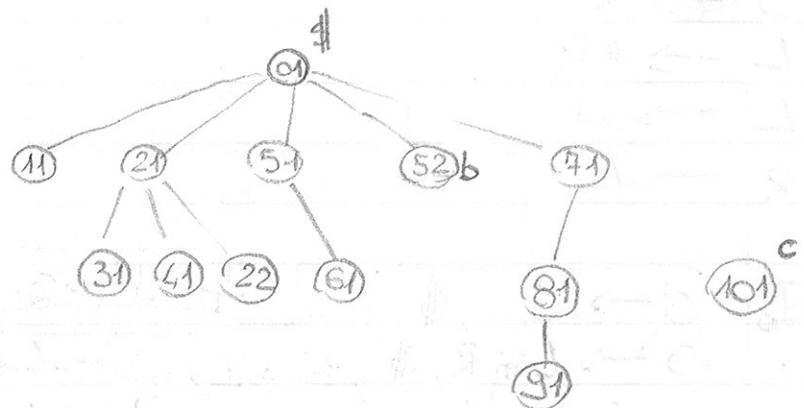
01 11, 21, 51, 52, 71

21 31, 41

51 61

71 81

81 91



- Generations

b generated by 01 for 52

c generated by 71 for 101

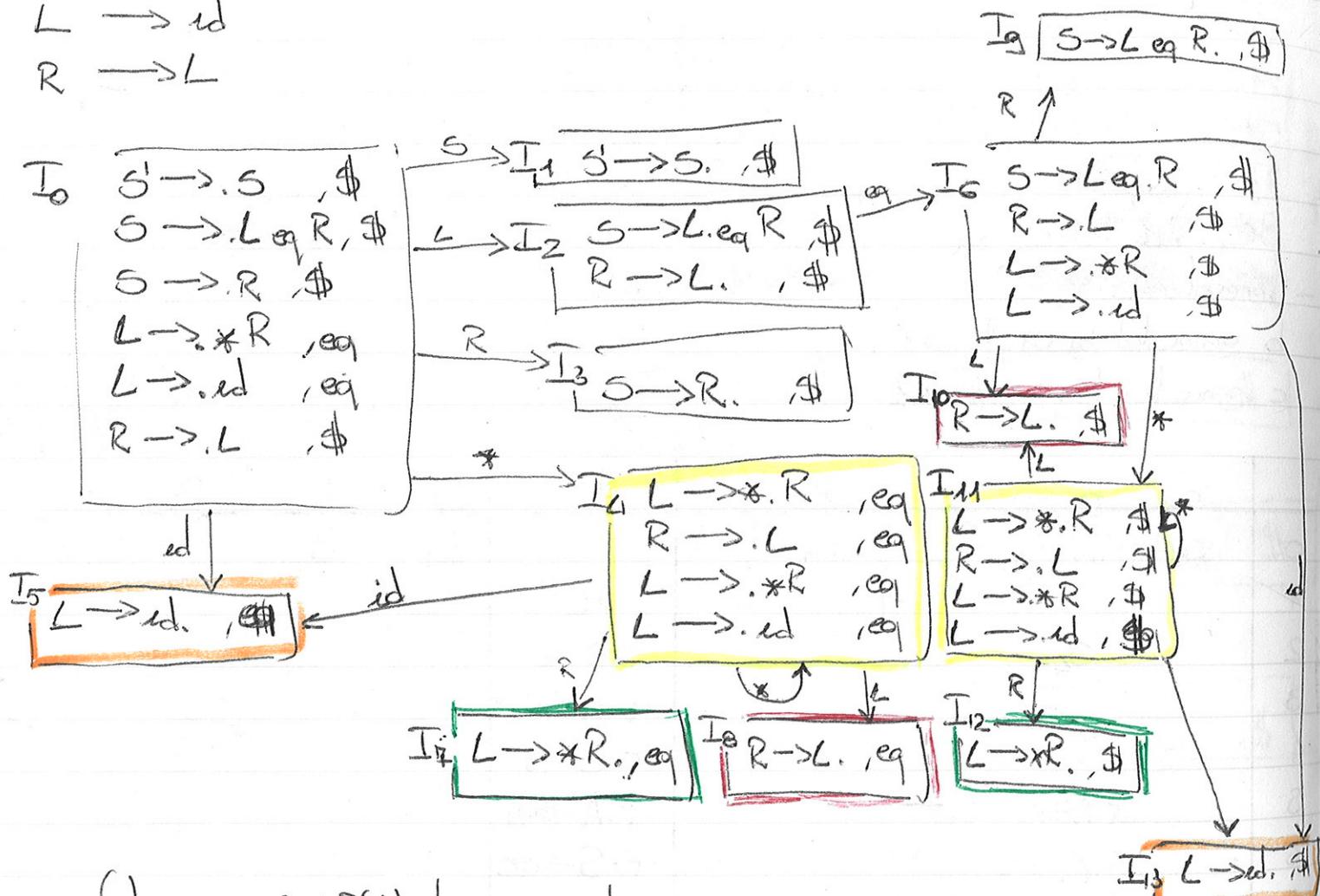
	a	b	c	x	\$	S	A	B
0	s ₅			s ₇		g ₁	g ₂	
1					r: B → ε			
2		s ₄			r: S → AB			g ₃
3					r: S → b			
4					r: A → a			
5			s ₆		r: S → ac			
6								
7	s ₁₀						g ₈	
8								
9			s ₉					
10				r: A → a	r: S → xAc			

0	x a c \$
0 x 7	x c \$
0 x 7 a b	c \$
0 x 7 A 8	x \$
0 x 7 A 8 x b	\$
0 s 1	\$

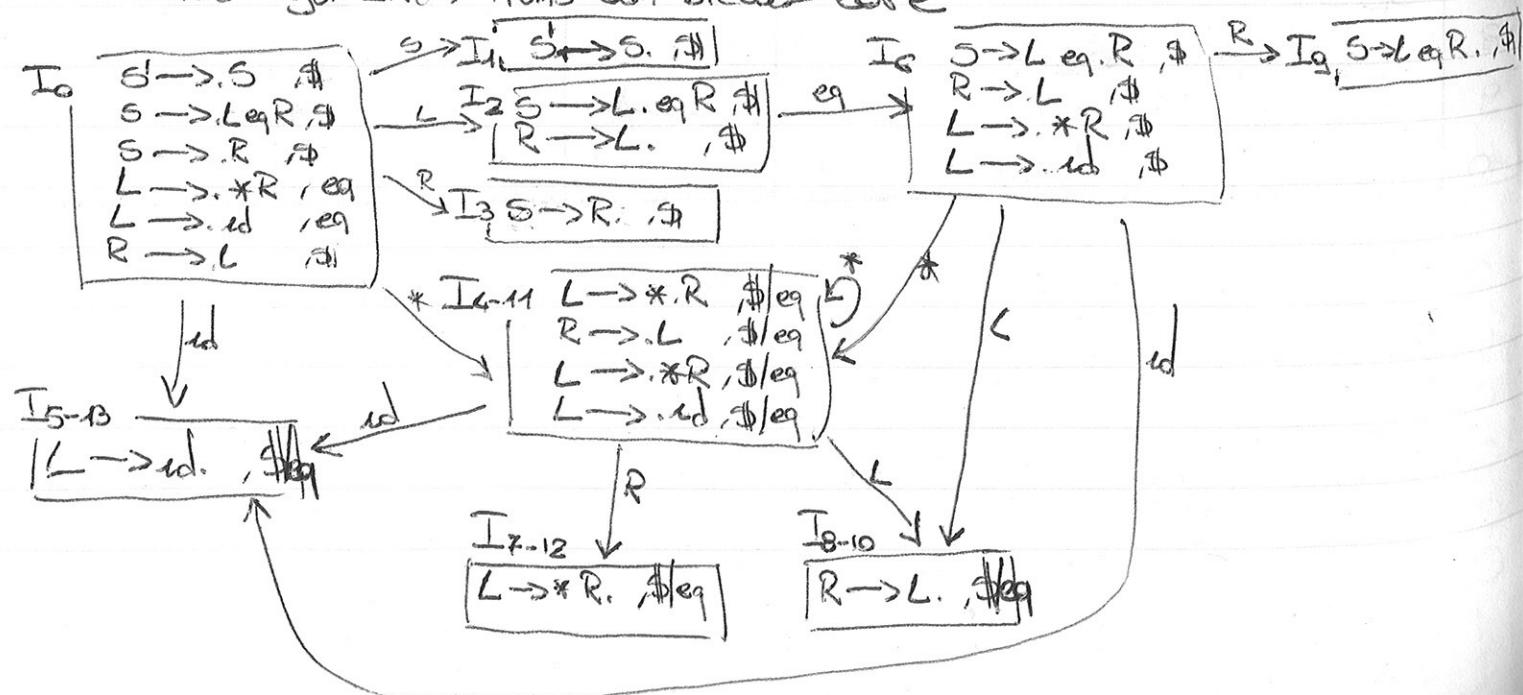
shift 7
shift 10
Reduce A → a
shift 9
Reduce S → xAc
ACC

LALR $\left(\begin{matrix} \text{Unembed LR(1) items} \\ \text{stereo core} \end{matrix} \right)$

- $S \rightarrow L$ eq R
- $S \rightarrow R$
- $L \rightarrow *R$
- $L \rightarrow id$
- $R \rightarrow L$



Unisci gli LR(1) items con stesso core

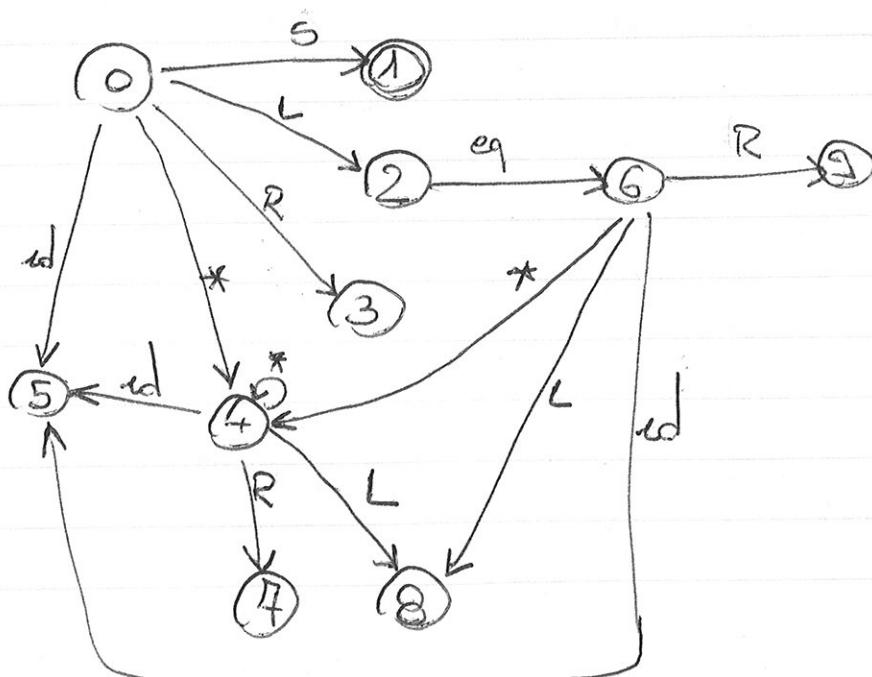
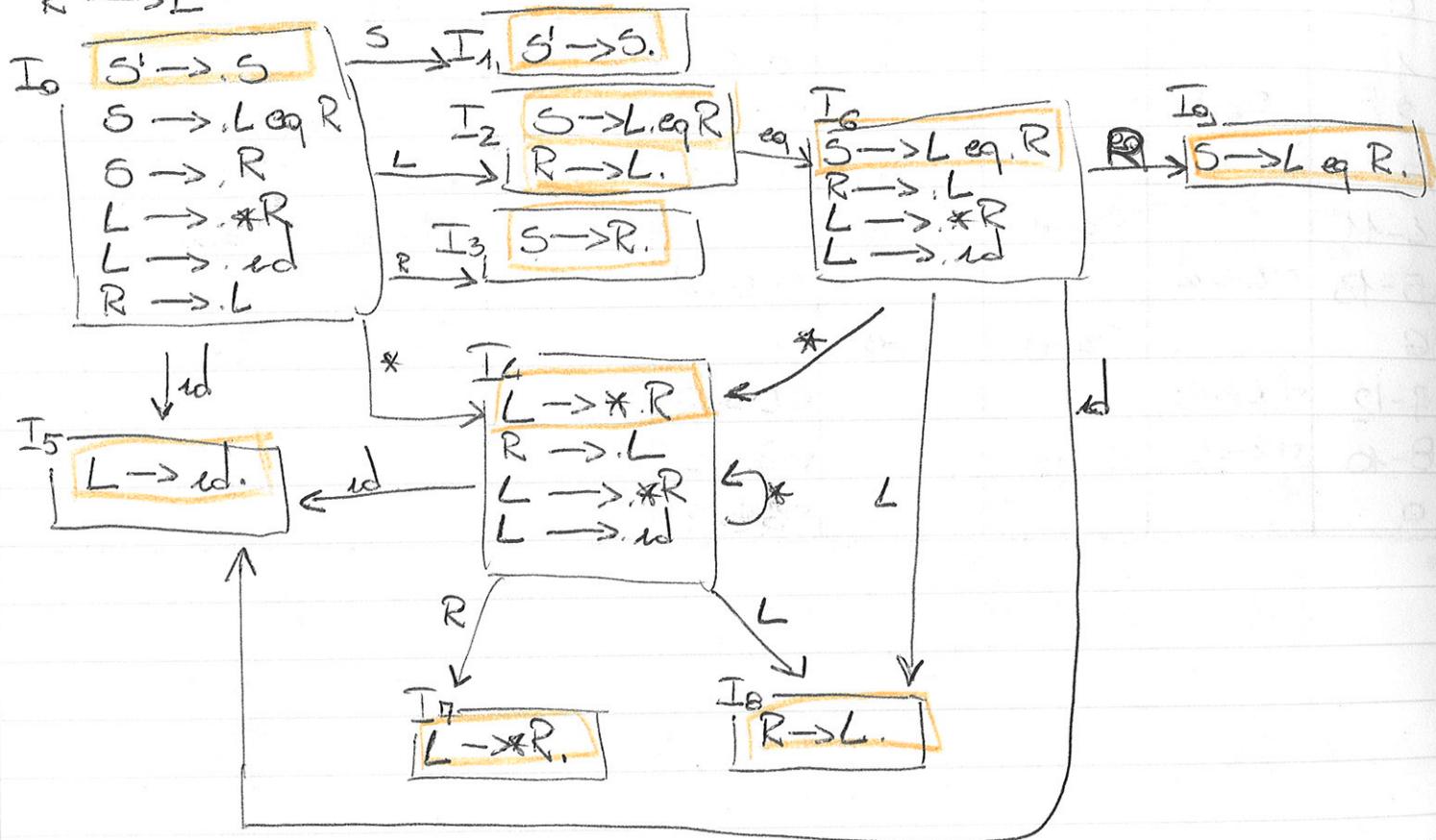


	\oplus	*	id	\$	S	L	R
0					g_1	g_2	g_3
1				acc			
2	s_6			$r: R \rightarrow L$			
3				$r: S \rightarrow R$			
4-11		s_{4-11}	s_{5-13}			g_{8-10}	g_{7-12}
5-13	$r: L \rightarrow \text{id}$			$r: L \rightarrow \text{id}$			
6		s_{4-11}	s_{5-13}			g_{8-10}	g_9
7-12	$r: L \rightarrow *R$			$r: L \rightarrow *R$			
8-10	$r: R \rightarrow L$			$r: R \rightarrow L$			
9				$r: \cancel{S} \rightarrow R$			

SLR | LALR
with Propagation Graph

$S \rightarrow L \text{ eq } R$
 $S \rightarrow R$
 $L \rightarrow *R$
 $L \rightarrow \text{id}$
 $R \rightarrow L$

	FIRST	FOLLOW
S	* id	\$
L	* id	eq \$
R	* id	\$ eq



Not SLR

	eq
2	$S \rightarrow \text{ reduction } "R \rightarrow L"$

01 $S' \rightarrow S$
 11 $S' \rightarrow S.$
 21 $S \rightarrow L. eqR$
 22 $R \rightarrow L.$
 31 $S \rightarrow R.$
 41 $L \rightarrow *R$
 51 $L \rightarrow id.$
 61 $S \rightarrow L eq.R$
 71 $L \rightarrow *R.$
 81 $R \rightarrow L.$
 91 $S \rightarrow L eq.R.$

01 $\boxed{S' \rightarrow S, f}$
 $S \rightarrow L eq.R, f$
 $S \rightarrow R, f$
 $L \rightarrow *R, f | eq$
 $L \rightarrow id, f | eq$
 $R \rightarrow L, f$

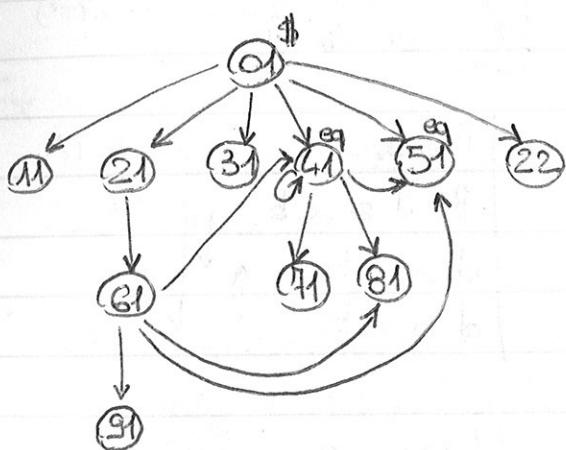
41 $L \rightarrow *R, f$
 $R \rightarrow L, f$
 $L \rightarrow *R, f$
 $L \rightarrow id, f$

51 $L \rightarrow id, f$

11 $\boxed{S \rightarrow S, f}$
 21 $\boxed{S \rightarrow L. eqR, f}$
 22 $\boxed{R \rightarrow L, f}$
 31 $\boxed{S \rightarrow R, f}$

61 $S \rightarrow L eq.R, f$
 $R \rightarrow L, f$
 $L \rightarrow *R, f$
 $L \rightarrow id, f$

71 $\boxed{L \rightarrow *R, f}$
 81 $\boxed{R \rightarrow L, f}$
 91 $\boxed{S \rightarrow L eq.R, f}$



Propagation
from to

01	11 21 31 41 51 22
21	61
41	71 81 41 51
61	81 81 41 51

Generation

eq is generated by 01 for 41 and 51

	eq	*	id	\$	S	L	R
0		S_4	S_5		g_1	g_2	g_3
1				acc			
2	S_6			$r: R \rightarrow L$			
3				$r: S \rightarrow R$			
4		S_4	S_5			g_8	g_7
5	$r: L \rightarrow id$						
6		S_4	S_5			g_8	g_9
7	$r: L \rightarrow *R$			$r: L \rightarrow *R$			
8	$r: R \rightarrow L$			$r: R \rightarrow L$			
9	$r: S \rightarrow L eq.R$			$r: S \rightarrow L eq.R$			

$$E \rightarrow E + T \mid T$$

$$T \rightarrow T * F \mid F$$

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

	FIRST	FOLLOW
E	(id	\$ +)
T	(id	\$ +) * { FOLLOW(E) }
F	(id	\$ +) * { FOLLOW(T) }

$$E \rightarrow TE'$$

$$E' \rightarrow +TE'^\dagger \mid \epsilon$$

$$T \rightarrow FT'$$

$$T' \rightarrow *FT'^\dagger \mid \epsilon$$

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

	FIRST	FOLLOW
E	(id	\$)
E'	+ E	\$ FOLLOW(E) }
T	(id	\$ FOLLOW(E) }
T'	* E	\$ FOLLOW(T) }
F	(id	* \$ FOLLOW(T) } e FOLLOW(T')

$$S \rightarrow ABc^2$$

$$A \rightarrow {}^2dB \mid {}^3cS \mid {}^4c$$

$$B \rightarrow {}^5AS \mid b^6$$

	FIRST	FOLLOW
S	d = c	\$ d = cb
A	d = c	d = cb
B	d = c b	d = cb

$$S \rightarrow LB$$

$$B \rightarrow := L \mid ; S ; L$$

$$L \rightarrow (E J$$

$$J \rightarrow , E J \mid)$$

$$E \rightarrow L \mid a$$

	FIRST	FOLLOW
S	(\$;
B	:= ;	\$;
L	(FIRST(B) {} := ; \$; FOLLOW(B) {} ; ,)
J	,	:= ; \$,)
E	a	,)

$$S \rightarrow aSA \mid \epsilon$$

$$A \rightarrow c \mid \epsilon$$

	FIRST	FOLLOW
S	a ϵ	\$ c
A	c ϵ	\$ c

$A \rightarrow iB \leftarrow e$
 $B \rightarrow SB \mid \epsilon$
 $S \rightarrow [eC] \mid i$
 $C \rightarrow eC \mid \epsilon$

	FIRST	
A	i	\$
B	[. ϵ	\leftarrow
S	[.	$\{ \text{First}(B) \setminus \epsilon \} \leftarrow \{ \text{Follow}(B) \}$
C	e ϵ]

$S \rightarrow aAa \mid \epsilon$
 $A \rightarrow abS \mid c$

	FIRST	
S	a ϵ	\$ a
A	a c	a

Ex

Nel parsing SLR è possibile usare una grammatica left-recursiva?

Una grammatica left-recursiva non è parsabile con tecnica LL(1), si finirebbe per ricorrere a sinistra all'infinito, ma con parsing di tipo LR (quindi anche SLR), tecnica bottom-up, la ricorsione sinistra (left-recursion) non è un problema.

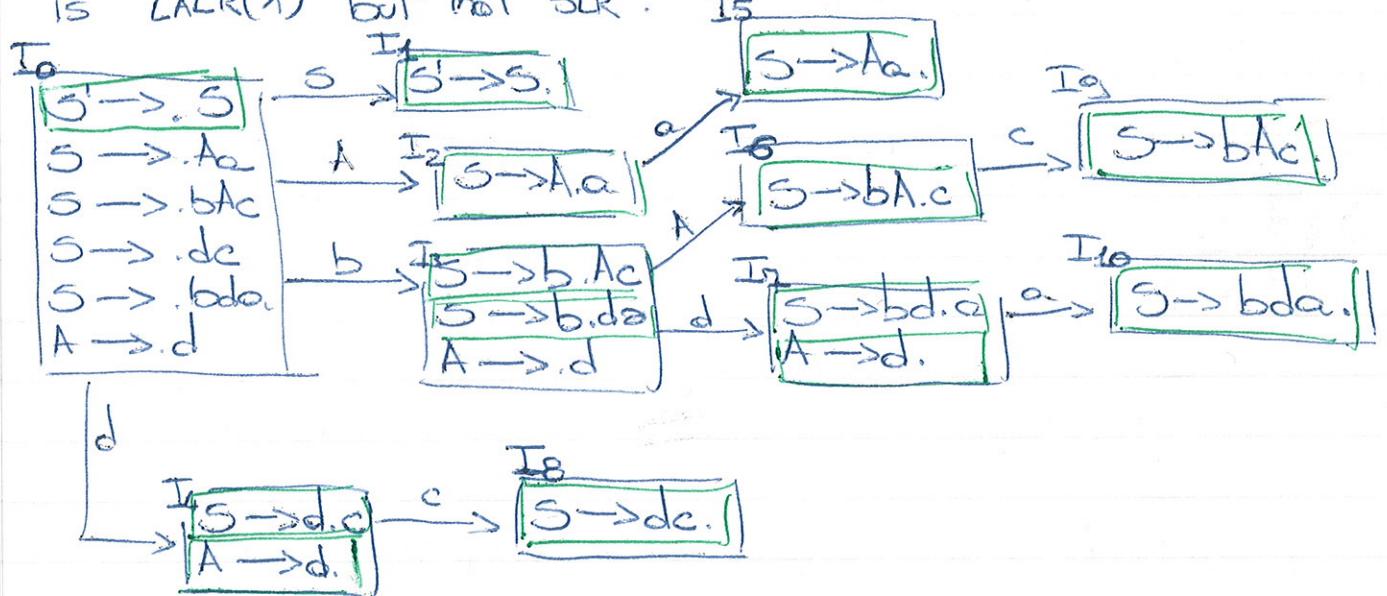
Ex 4.7.4 Librar page 278

Show that the following grammar

$$S \rightarrow Aa \mid bAc \mid d \mid bda$$

$$A \rightarrow d$$

is LALR(1) but not SLR.



FIRST	FOLLOW
S d b	\$
A d	a c

4	c
$S \rightarrow A.a$	d

So G is not SLR

01	$S' \rightarrow S$	51	$S \rightarrow A.a.$
11	$S' \rightarrow S.$	61	$S \rightarrow bAc.$
21	$S \rightarrow A.a$	41	$S \rightarrow bd.a$
31	$S \rightarrow b.Ac$	71	$S \rightarrow d.$
32	$S \rightarrow b.d \quad A \rightarrow d.$	81	$S \rightarrow dc.$
41	$S \rightarrow d.c$	91	$S \rightarrow bAc.$
42	$A \rightarrow d.$	101	$S \rightarrow bda.$

01	$S' \rightarrow S$, \$
	$S \rightarrow A.a$, \$
	$S \rightarrow bAc$, \$
	$S \rightarrow dc$, \$
	$S \rightarrow bda$, \$
	$A \rightarrow d$, a

31	$S \rightarrow b.Ac$, \$
	$A \rightarrow d$, c

Propagation
from
top

01	11	21	31	41	32
21	51				
31	61				
32	71				
41	81				
61	91				
71	101				

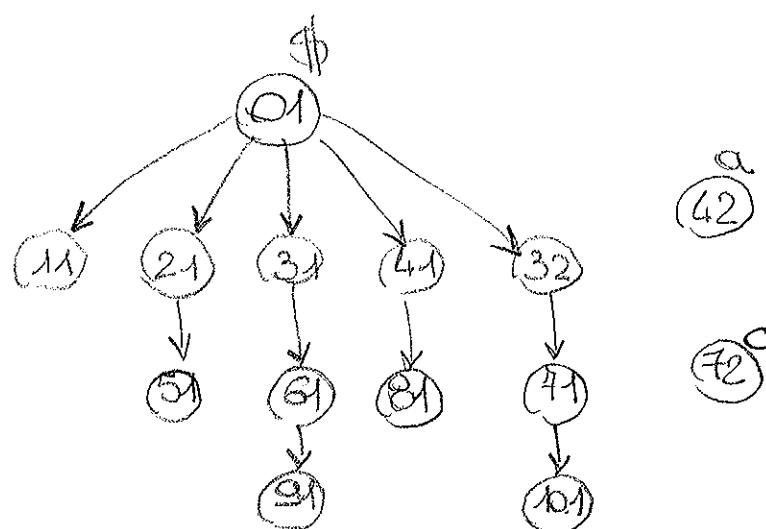
Generation

a for 42

c for 72

by 01

by 31



	a	b	c	d	e	f	g	A
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Annotations:

- Row 1: a
- Row 2: b
- Row 3: c
- Row 4: d
- Row 5: e
- Row 6: f
- Row 7: g
- Row 8: A
- Column 1: 0
- Column 2: 1
- Column 3: 2
- Column 4: 3
- Column 5: 4
- Column 6: 5
- Column 7: 6
- Column 8: 7
- Column 9: 8

Annotations in the table cells:

- Cell (1, 2): s_3
- Cell (2, 2): s_5
- Cell (3, 2): $r: A \rightarrow d$
- Cell (4, 2): s_6
- Cell (5, 2): s_7
- Cell (6, 2): s_8
- Cell (7, 2): $r: A \rightarrow d$
- Cell (8, 2): s_9
- Cell (9, 2): $r: A \rightarrow d$
- Cell (1, 3): s_4
- Cell (2, 3): s_6
- Cell (3, 3): s_7
- Cell (4, 3): s_8
- Cell (5, 3): s_9
- Cell (6, 3): s_{10}
- Cell (7, 3): $r: s \rightarrow d_0$
- Cell (8, 3): $r: s \rightarrow bAc$
- Cell (9, 3): $r: s \rightarrow bda$
- Cell (1, 4): s_4
- Cell (2, 4): s_7
- Cell (3, 4): s_8
- Cell (4, 4): s_9
- Cell (5, 4): s_{10}
- Cell (6, 4): $r: s \rightarrow d_0$
- Cell (7, 4): $r: s \rightarrow bAc$
- Cell (8, 4): $r: s \rightarrow bda$
- Cell (1, 5): s_4
- Cell (2, 5): s_7
- Cell (3, 5): s_8
- Cell (4, 5): s_9
- Cell (5, 5): s_{10}
- Cell (6, 5): $r: s \rightarrow d_0$
- Cell (7, 5): $r: s \rightarrow bAc$
- Cell (8, 5): $r: s \rightarrow bda$
- Cell (1, 6): s_4
- Cell (2, 6): s_7
- Cell (3, 6): s_8
- Cell (4, 6): s_9
- Cell (5, 6): s_{10}
- Cell (6, 6): $r: s \rightarrow d_0$
- Cell (7, 6): $r: s \rightarrow bAc$
- Cell (8, 6): $r: s \rightarrow bda$
- Cell (1, 7): s_4
- Cell (2, 7): s_7
- Cell (3, 7): s_8
- Cell (4, 7): s_9
- Cell (5, 7): s_{10}
- Cell (6, 7): $r: s \rightarrow d_0$
- Cell (7, 7): $r: s \rightarrow bAc$
- Cell (8, 7): $r: s \rightarrow bda$
- Cell (1, 8): s_4
- Cell (2, 8): s_7
- Cell (3, 8): s_8
- Cell (4, 8): s_9
- Cell (5, 8): s_{10}
- Cell (6, 8): $r: s \rightarrow d_0$
- Cell (7, 8): $r: s \rightarrow bAc$
- Cell (8, 8): $r: s \rightarrow bda$

G 15 LALR(1)