

CSEN 1003 Compiler, Spring Term 2020
Practice Assignment 7

Exercise 7-1

LR(0) Automaton

Is it possible that the following items constitute an item set in an LR(0) automaton? Justify your answer.

$$\begin{array}{lcl} A & \rightarrow & P.Q \\ P & \rightarrow & .e \\ Q & \rightarrow & .e \end{array}$$

Solution:

The item set must be complete: so the answer is NO: $P \rightarrow .e$ should not be part of it as we entered this set on a shift on P.

(Note that we can add the item $Q \rightarrow .P$ to create a complete valid item set, but this was not the question!). Whether or not an item set makes the grammar LR(0) or not does not define the validity of an item set.

Exercise 7-2

LR(0) Item sets

Which of the following pairs of terms can co-exist in an LR(0) item set:

a)
$$\begin{array}{lcl} A & \rightarrow & P.Q \\ B & \rightarrow & QP. \end{array}$$

Solution:

Yes. Both correspond to a shift on P , but to co-exist we need to show that the items are related. So we could have the previous state as $B \rightarrow Q.P$ with the additional item $P \rightarrow .A$ and $A \rightarrow .PQ$ Now a shift on P gives the items above as co-existing items.

b)
$$\begin{array}{lcl} A & \rightarrow & P.Q \\ B & \rightarrow & PQ. \end{array}$$

Solution:

No, because one corresponds to a shift on P , while the second item corresponds to a shift on Q . We cannot connect these items.

c)
$$\begin{array}{lcl} A & \rightarrow & P.Q \\ B & \rightarrow & P.Q \end{array}$$

Solution:

⁰Exercises are due to Dr. Carmen Gervet and Pearson textbook

Yes with $P \rightarrow B$ for instance as extra production (thus in the previous state we have $A \rightarrow .PQ$, $P \rightarrow .B$ and $B \rightarrow .PQ$). A shift on P yields the items.

$$\begin{array}{lcl} \text{d)} & A & \rightarrow P.Q \\ & A & \rightarrow .Q \end{array}$$

Solution:

Yes, if $Q \rightarrow A$ is part of the grammar.

Exercise 7-3

LR(0) Automaton and SLR Parsing

Consider the following grammar:

$$\begin{array}{lcl} S & \rightarrow & Xa \\ X & \rightarrow & a \mid aXb \end{array}$$

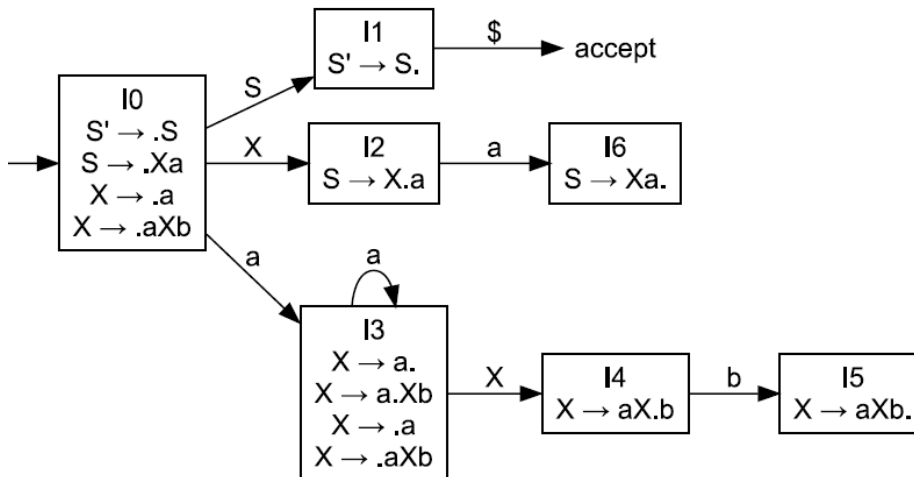
a) Compute the LR(0) item sets and construct the DFA of the augmented grammar.

Solution:

Augmented grammar:

$$\begin{array}{lcl} S' & \rightarrow & S \\ S & \rightarrow & Xa \\ X & \rightarrow & a \mid aXb \end{array}$$

DFA:



b) Construct the SLR parsing table.

Solution:

Rule numbering:

1. $S \rightarrow Xa$
2. $X \rightarrow a$
3. $X \rightarrow aXb$

Parsing table:

State	Action			GOTO	
	a	b	\$	S	X
0	s3			1	2
1			acc		
2	s6				
3	s3,r2	r2			4
4		s5			
5	r3	r3			
6			r1		

Note: The table above shows that the grammar is *not* SLR(1) since there is a shift/reduce conflict in state I_3 . However, in this case it is safe to always resolve the conflict in favor of shifting.

- c) Use the parsing table to simulate SLR parsing on the string: aaba

Solution:

Stack	Input	Action
0	aaba\$	shift
03	aba\$	shift
033	ba\$	reduce $X \rightarrow a$
034	ba\$	shift
0345	a\$	reduce $X \rightarrow aXb$
02	a\$	shift
026	\$	reduce $S \rightarrow Xa$
01	\$	accept

Exercise 7-4

LR(0) Automaton and SLR Parsing

Consider the following grammar:

$$\begin{aligned} S &\rightarrow aSc \mid Td \\ T &\rightarrow Tb \mid b \end{aligned}$$

- a) Compute the LR(0) item sets and construct the DFA of the augmented grammar.

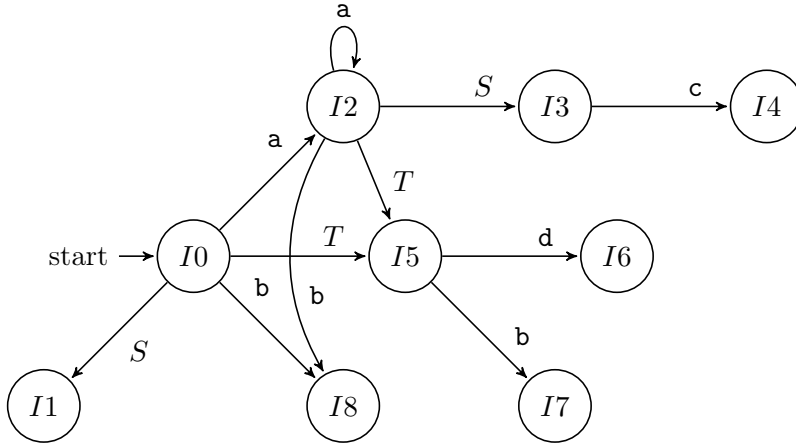
Solution:

Augmented Grammar:

$$\begin{aligned} S' &\rightarrow S \\ S &\rightarrow aSc \mid Td \\ T &\rightarrow Tb \mid b \end{aligned}$$

LR(0) Item sets:

$I_0:$ $S' \rightarrow \cdot S$ $S \rightarrow \cdot aSc$ $S \rightarrow \cdot Td$ $T \rightarrow \cdot Tb$ $T \rightarrow \cdot b$	$I_1:$ $S' \rightarrow S \cdot$	$I_2:$ $S \rightarrow a \cdot Sc$ $S \rightarrow \cdot aSc$ $S \rightarrow \cdot Td$ $T \rightarrow \cdot Tb$ $T \rightarrow \cdot b$
$I_3:$ $S \rightarrow aS \cdot c$	$I_4:$ $S \rightarrow aSc \cdot$	$I_5:$ $S \rightarrow T \cdot d$ $T \rightarrow T \cdot b$
$I_6:$ $S \rightarrow Td \cdot$	$I_7:$ $T \rightarrow Tb \cdot$	$I_8:$ $T \rightarrow b \cdot$



b) Construct the SLR parsing table.

Solution:

Rule numbering:

1. $S \rightarrow aSc$
2. $S \rightarrow Td$
3. $T \rightarrow Tb$
4. $T \rightarrow b$

Parsing table:

State	Action					GOTO	
	a	b	c	d	\$	S	X
0	s2	s8				1	5
1					acc		
2	s2	s8				3	5
3			s4				
4			r1		r1		
5		s7		s6			
6			r2		r2		
7		r3		r3			
8		r4		r4			

c) Is this grammar SLR ? Justify your answer.

Solution:

The table above shows that the grammar is SLR since there is no conflicts.

- d) Use the parsing table to simulate SLR parsing on the string: **aabdcc**

Solution:

Stack	Input	Action
0	aabdcc\$	shift
0 2	abdcc\$	shift
0 2 2	bdcc\$	shift
0 2 2 8	dcc\$	reduce $T \rightarrow \mathbf{b}$
0 2 2 5	dcc\$	shift
0 2 2 5 6	cc\$	reduce $S \rightarrow T\mathbf{b}$
0 2 2 3	cc\$	shift
0 2 2 3 4	c\$	reduce $S \rightarrow \mathbf{a}Sc$
0 2 3	c\$	shift
0 2 3 4	\$	reduce $S \rightarrow \mathbf{a}Sc$
0 2 1	\$	accept

Exercise 7-5

Consider the following grammar:

$$S \rightarrow T, S \mid \varepsilon$$

$$T \rightarrow \text{int } 0$$

- a) Compute the LR(0) item sets and construct the DFA of the augmented grammar.

Solution:

Augmented Grammar:

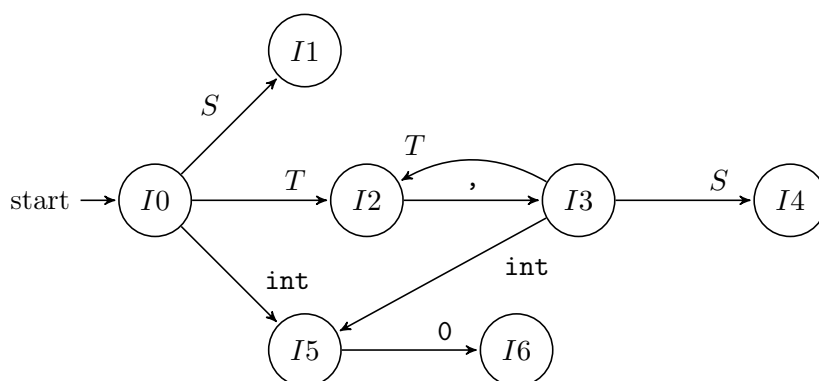
$$S' \rightarrow S$$

$$S \rightarrow T, S \mid \varepsilon$$

$$T \rightarrow \text{int } 0$$

LR(0) Item sets:

$I_0:$ $S' \rightarrow \cdot S$ $S \rightarrow \cdot T, S$ $S \rightarrow \cdot$ $T \rightarrow \cdot \text{int } 0$	$I_1:$ $S' \rightarrow S \cdot$	$I_2:$ $S \rightarrow T \cdot, S$
$I_3:$ $S \rightarrow T, \cdot S$ $S \rightarrow \cdot T, S$ $S \rightarrow \cdot$ $T \rightarrow \cdot \text{int } 0$	$I_4:$ $S \rightarrow T, S \cdot$	$I_5:$ $T \rightarrow \text{int } \cdot 0$



b) Construct the SLR parsing table.

Solution:

Rule numbering:

1. $S \rightarrow T, S$
2. $S \rightarrow \epsilon$
3. $T \rightarrow \text{int } 0$

Parsing table:

State	Action				GOTO	
	int	0	,	\$	S	X
0	s5			r2	1	2
1				acc		
2			s3			
3	s5			r2	4	2
4				r1		
5		s6				
6		r3				

c) Is this grammar SLR ? Justify your answer.

Solution:

The table above shows that the grammar is SLR since there are no conflicts.

d) Use the parsing table to simulate SLR parsing on the string: `int 0 , int 0`

Solution:

Stack	Input	Action
0	int 0 , int 0\$	shift
05	0 , int 0\$	shift
056	, int 0\$	reduce $T \rightarrow \text{int } 0$
02	, int 0\$	shift
023	int 0\$	shift
0235	0\$	shift
02356	\$	Error