CS 335 Assignment 2

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1 Problem 1

For the given grammar, after removing the left recursion, the following grammar forms:

S → (L)|a
L → bL'
L' → ,SL' | SL' | ϵ

Following are the the First set for are the non terminals:

First(S) : { (, a }
First(L) : { b }
First(L') : { (, a , ',' ,ϵ }

Following are the the Follow set for are the non terminals:

First(S) : { \$, (, a , ',' ,) }
First(L) : {) }
First(L') : {) }

Using the above grammar and above first and follow sets, following is the parsing table:

Non- Terminal	Input Symbol					
	(	a	b	,	)	\$
S	S→(L)	S→a				
L			L→bL'			
L'	L'→SL'	L'→SL'		L'→,SL'	L'→ ϵ	

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2 Problem 2

Add an extra rule S'→S as an initial rule.
Rules:

  (0) S' → S
  (1) S → Lp
  (2) S → qLr
  (3) S → sr
  (4) S → qsp
  (5) L → s

Now following are the Items in the Canonical Collection of Sets of LR(1):

I_0 = Closure(S' → S)={

  S' → .S , $
  S → .Lp , $
  S → .qLr , $
  S → .sr , $
  S → .qsp , $
  L → .s , p

}

I_1 = Goto(I_0,S)={

  S' → S. , $

}

I_2 = Goto(I_0,L)={

  S → L.p , $

}

I_3 = Goto(I_0,q)={

  S → q.Lr , $
  S → q.sp , $
  L → .s , r

}

I_4 = Goto(I_0,s)={

  S → s.r , $
  L → s. , p

}

I_5 = Goto(I_2,p)={

  S → Lp. , $

}

I_6 = Goto(I_3,L)={

S → qL.r , $
}
I$_7$ = Goto(I$_3$,s)={
    S → qs.p , $
    L → s. , r
}
I$_8$ = Goto(I$_4$,r)={
    S → sr. , $
}
I$_9$ = Goto(I$_6$,r)={
    S → qLr. , $
}
I$_{10}$ = Goto(I$_7$,p)={
    S → qsp. , $
}
State diagram:
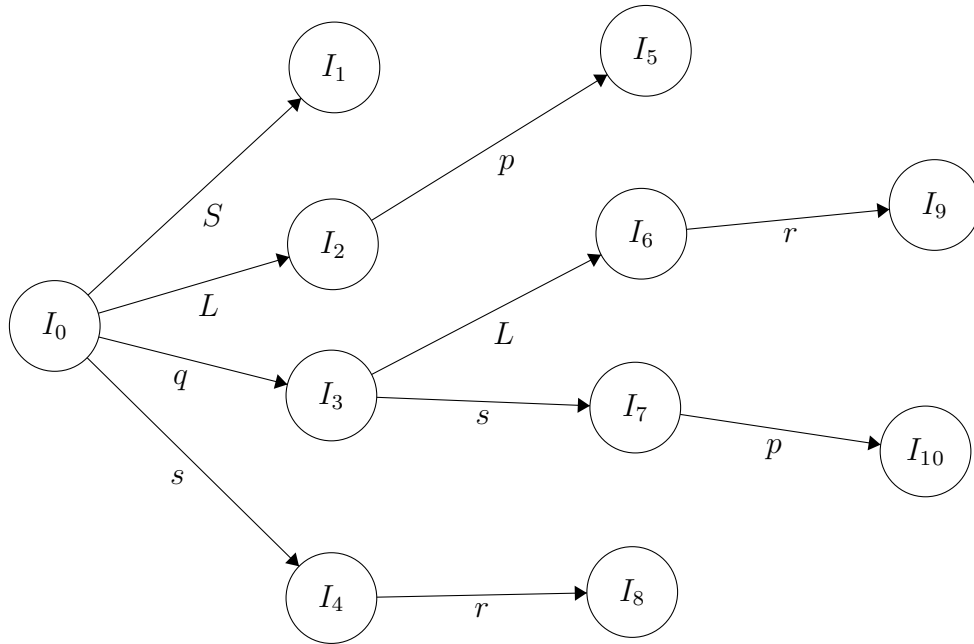
LR(1) parsing table based on the above states:

	Action					Goto	
State	p	q	r	s	$	S	A
0		s3		s4		1	2
1					acc		
2	s5						
3				s7			6
4	r5		s8				
5							
6			s9				
7	s10		r5				
8					r3		
9					r2		
10					r4		

Looking at the States we can say that no merging occurs, so this is also the final LALR(1) table
Hence the given grammar is LALR(1)

Now following are the Items in the Canonical Collection of Sets of LR(0):
I_0 = Closure(S' → S)={
    S' → .S
    S → .Lp
    S → .qLr
    S → .sr
    S → .qsp
    L → .s
}
I_1 = Goto(I_0,S)={
    S' → S.
}
I_2 = Goto(I_0,L)={
    S → L.p
}
I_3 = Goto(I_0,q)={
    S → q.Lr
    S → q.sp
    L → .s
}
I_4 = Goto(I_0,s)={

$S \rightarrow s.r$

$L \rightarrow s.$

}

$I_5 = \text{Goto}(I_2,p)=\{$

$S \rightarrow Lp.$

}

$I_6 = \text{Goto}(I_3,L)=\{$

$S \rightarrow qL.r$

}

$I_7 = \text{Goto}(I_3,s)=\{$

$S \rightarrow qs.p$

$L \rightarrow s.$

}

$I_8 = \text{Goto}(I_4,r)=\{$

$S \rightarrow sr.$

}

$I_9 = \text{Goto}(I_6,r)=\{$

$S \rightarrow qLr.$

}

$I_{10} = \text{Goto}(I_7,p)=\{$

$S \rightarrow qsp.$

}

Now Action[4,r] = Shift(8) and also Action[4,r] = Reduce(L$\rightarrow$s) since 'r' is in Follow(L). So there is a shift-reduce conflict, hence this grammar is not SLR.

3   Problem 3

Since R is in the right hand side of some production rules, add an extra rule (S $\rightarrow$ R) in as the initial rule.

Rules:

(0) S $\rightarrow$ R

(1) R $\rightarrow$ R$'$ |$'$R

(2) R $\rightarrow$ RR

(3) R $\rightarrow$ R*

(4) R $\rightarrow$ (R)

(5) R $\rightarrow$ a

(6) R → b

Now following are the Items in the Canonical Collection of Sets of LR(0):
I_0 = Closure(S → R)={
    S → .R
    R → .R' |'R
    R → .RR
    R → .R*
    R → .(R)
    R → .a
    R → .b
}
I_1 = Goto(I_0,R)={
    S → R.
    R → R.' |'R
    R → R.R
    R → R.*
    R → .R' |'R
    R → .RR
    R → .R*
    R → .(R)
    R → .a
    R → .b
}
I_2 = Goto(I_0,()={
    R → (.R)
    R → .R' |'R
    R → .RR
    R → .R*
    R → .(R)
    R → .a
    R → .b
}
I_3 = Goto(I_0,a)={
    R → a.
}
I_4 = Goto(I_0,b)={
    R → b.

}
$I_5 = \text{Goto}(I_1, |) = \{$

    $R \to R' \ |'.R$

    $R \to .R' \ |'R$

    $R \to .RR$

    $R \to .R*$

    $R \to .(R)$

    $R \to .a$

    $R \to .b$

}
$I_6 = \text{Goto}(I_1, R) = \{$

    $R \to RR.$

    $R \to R.' \ |'R$

    $R \to R.R$

    $R \to R.*$

    $R \to .R' \ |'R$

    $R \to .RR$

    $R \to .R*$

    $R \to .(R)$

    $R \to .a$

    $R \to .b$

}
$I_7 = \text{Goto}(I_1, *) = \{$

    $R \to R*.$

}
$I_2 = \text{Goto}(I_1, ()$

$I_3 = \text{Goto}(I_1, a)$

$I_4 = \text{Goto}(I_1, b)$

$I_8 = \text{Goto}(I_2, R) = \{$

    $R \to (R.)$

    $R \to R.' \ |'R$

    $R \to R.R$

    $R \to R.*$

    $R \to .R' \ |'R$

    $R \to .RR$

    $R \to .R*$

    $R \to .(R)$

    $R \to .a$

$R \rightarrow .b$

}

$I_2 = Goto(I_1,()$

$I_3 = Goto(I_1,a)$

$I_4 = Goto(I_1,b)$

$I_9 = Goto(I_5,R)=\{$

$\quad R \rightarrow R' \mid 'R.$

$\quad R \rightarrow R.' \mid 'R$

$\quad R \rightarrow R.R$

$\quad R \rightarrow R.*$

$\quad R \rightarrow .R' \mid 'R$

$\quad R \rightarrow .RR$

$\quad R \rightarrow .R*$

$\quad R \rightarrow .(R)$

$\quad R \rightarrow .a$

$\quad R \rightarrow .b$

}

$I_4 = Goto(I_5,()$

$I_3 = Goto(I_5,a)$

$I_4 = Goto(I_5,b)$

$I_5 = Goto(I_6,\mid)$

$I_6 = Goto(I_6,R)$

$I_7 = Goto(I_6,*)$

$I_2 = Goto(I_6,()$

$I_3 = Goto(I_6,a)$

$I_4 = Goto(I_6,b)$

$I_{10} = Goto(I_8,))=\{$

$\quad R \rightarrow (R).$

}

$I_5 = Goto(I_8,\mid)$

$I_6 = Goto(I_8,R)$

$I_7 = Goto(I_8,*)$

$I_2 = Goto(I_8,()$

$I_3 = Goto(I_8,a)$

$I_4 = Goto(I_8,b)$

$I_5 = Goto(I_9,\mid)$

$I_6 = Goto(I_9,R)$

$I_7 = Goto(I_9,*)$

$I_2 = \text{Goto}(I_9,()$
$I_3 = \text{Goto}(I_9,a)$
$I_4 = \text{Goto}(I_9,b)$

Now we can find some shift reduce conflicts in the above items, for example from state 6 on input b it will either shift to state 4 or reduce by production rule 2 as b is in follow(R).
To resolve this problem we can use the operator precedence :

() > * > concatenation > |.

Using this precedence parsing table is as follows:

State	Action							Goto
	|	(	)	a	b	*	$	R
0		s2		s3	s4			1
1	s5	s2		s3	s4	s7	acc	6
2		s2		s3	s4			8
3	r5	r5	r5	r5	r5	r5	r5	
4	r6	r6	r6	r6	r6	r6	r6	
5		s2		s3	s4			9
6	r2	r2	r2	r2	r2	r7	r2	6
7	r3	r3	r3	r3	r3	r3	r3	
8	s5	s2	s10	s3	s4	s7		6
9	r1	s2	r1	s3	s4	s7	r1	6
10	r4	r4	r4	r4	r4	r4	r4	

4 Problem 4

Run the file run.sh in terminal. It will ask for input file. Provide a valid text input file and hit enter. It will create corresponding output file.
Format in which I have printed:
Title
Table of contents
Number all all the things asked
Tools Used: I have used yacc and flex.