Parsing:
CLR(1) & LALR(1)

How to add lookahead with the production?

CASE 1 –

- A->∝.BC, a
- Suppose this is the 0th production. Now, since ‘ . ‘ precedes B, so we have to write B’s productions as well.
- B->.D [1st production]
- Suppose this is B’s production. The look ahead of this production is given as- we look at previous production i.e. – 0th production. Whatever is after B, we find FIRST(of that value) , that is the lookahead of 1st production. So, here in 0th production, after B, C is there. Assume FIRST(C)=d, then 1st production become.
- B->.D, d

How to add lookahead with the production?

CASE 2 –

Now if the 0th production was like this,

- A->∝.B, a
- Here,we can see there's nothing after B. So the lookahead of 0th production will be the lookahead of 1st production. ie-
- B->.D, a

How to add lookahead with the production?

CASE 3 –

Assume a production A->a|b

- A->a,$ [0th production]
- A->b,$ [1st production]
- Here, the 1st production is a part of the previous production, so the lookahead will be the same as that of its previous production.

Steps for constructing the LALR parsing table :

1. Writing augmented grammar
2. LR(1) collection of items to be found
3. Defining 2 functions: goto[list of terminals] and action[list of non-terminals] in the LALR parsing table

EXAMPLE

Construct CLR parsing table for the given context free grammar

S-->AA

A-->aA|b

Solution:

STEP1- Find augmented grammar

The augmented grammar of the given grammar is:-

- S'-->.S ,$ [0th production]
- S-->.AA ,$ [1st production]
- A-->.aA ,a|b [2nd production]
- A-->.b ,a|b [3rd production]

CLR(1)

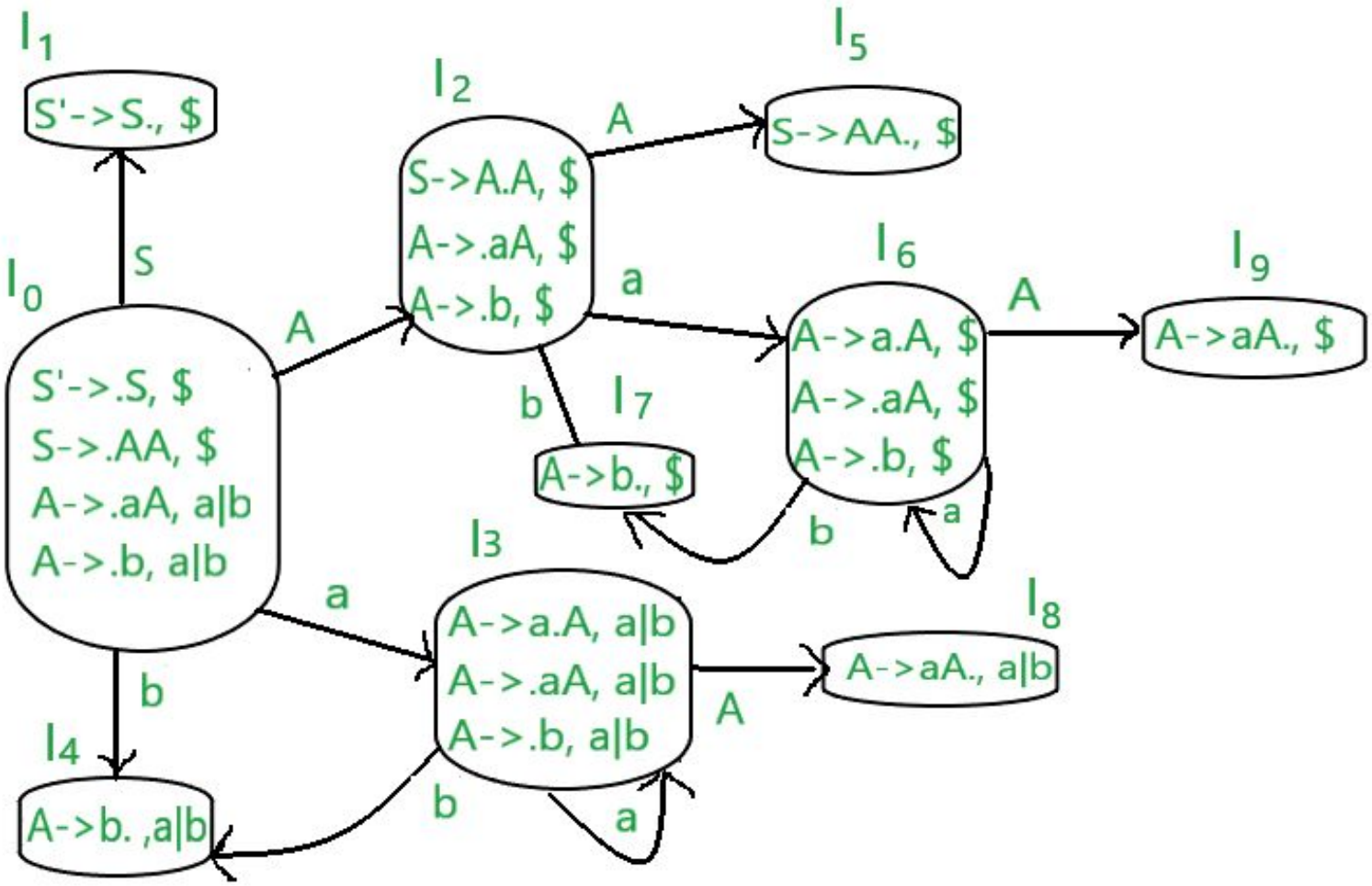
Let's apply the rule of lookahead to the above productions.

- The initial look ahead is always $
- Now, the 1st production came into existence because of ' . ' before 'S' in 0th production. There is nothing after 'S', so the lookahead of 0th production will be the lookahead of 1st production. i.e. : S–>.AA ,$
- Now, the 2nd production came into existence because of ' . ' before 'A' in the 1st production. After 'A', there's 'A'. So, FIRST(A) is a, b. Therefore, the lookahead of the 2nd production becomes a|b.
- Now, the 3rd production is a part of the 2nd production. So, the look ahead will be the same.

CLR(1)

- **STEP2** – Find LR(0) collection of items Below is the figure showing the LR(0) collection of items. We will understand everything one by one.
- The terminals of this grammar are {a,b} The non-terminals of this grammar are {S,A}

CLR(1) DFA


I0
S'->.S, $
S->.AA, $
A->.aA, a|b
A->.b, a|b
I1
S'->S., $
I2
S->A.A, $
A->.aA, $
A->.b, $
I3
A->a.A, a|b
A->.aA, a|b
A->.b, a|b
I4
A->b. ,a|b
I5
S->AA., $
I6
A->a.A, $
A->.aA, $
A->.b, $
I7
A->b., $
I8
A->aA., a|b
I9
A->aA., $
S
A
a
b
A
a
b
A
a
b
A
a
b

CLR(1)

RULES –

- If any non-terminal has ‘ . ‘ preceding it, we have to write all its production and add ‘ . ‘ preceding each of its production.
- from each state to the next state, the ‘ . ‘ shifts to one place to the right.
- In the figure, I0 consists of augmented grammar.
- Io goes to I1 when ‘ . ‘ of 0th production is shifted towards the right of S(S’->S.). This state is the accept state . S is seen by the compiler. Since I1 is a part of the 0th production, the lookahead is same i.e. $

CLR(1)

- Io goes to I2 when ‘ . ‘ of 1st production is shifted towards right (S->A.A) . A is seen by the compiler. Since I2 is a part of the 1st production, the lookahead is same i.e. $.
- I0 goes to I3 when ‘ . ‘ of 2nd production is shifted towards the right (A->a.A) . a is seen by the compiler.since I3 is a part of 2nd production, the lookahead is same i.e. a|b.
- I0 goes to I4 when ‘ . ‘ of 3rd production is shifted towards right (A->b.) . b is seen by the compiler. Since I4 is a part of 3rd production, the lookahead is same i.e. a|b.

CLR(1)

- I2 goes to I5 when ‘ . ‘ of 1st production is shifted towards right (S->AA.) . A is seen by the compiler. Since I5 is a part of the 1st production, the lookahead is same i.e. $.
- I2 goes to I6 when ‘ . ‘ of 2nd production is shifted towards the right (A->a.A) . A is seen by the compiler. Since I6 is a part of the 2nd production, the lookahead is same i.e. $.
- I2 goes to I7 when ‘ . ‘ of 3rd production is shifted towards right (A->b.) . A is seen by the compiler. Since I6 is a part of the 3rd production, the lookahead is same i.e. $.

CLR(1)

- I3 goes to I3 when ‘ . ‘ of the 2nd production is shifted towards right (A->a.A) . a is seen by the compiler. Since I3 is a part of the 2nd production, the lookahead is same i.e. a|b.
- I3 goes to I8 when ‘ . ‘ of 2nd production is shifted towards the right (A->aA.) . A is seen by the compiler. Since I8 is a part of the 2nd production, the lookahead is same i.e. a|b.
- I6 goes to I9 when ‘ . ‘ of 2nd production is shifted towards the right (A->aA.) . A is seen by the compiler. Since I9 is a part of the 2nd production, the lookahead is same i.e. $.

CLR(1)

- I6 goes to I6 when ‘ . ‘ of the 2nd production is shifted towards right (A->a.A) . a is seen by the compiler. Since I6 is a part of the 2nd production, the lookahead is same i.e. $.
- I6 goes to I7 when ‘ . ‘ of the 3rd production is shifted towards right (A->b.) . b is seen by the compiler. Since I6 is a part of the 3rd production, the lookahead is same i.e. $.

CLR(1)

- **STEP 3 –**
  Defining 2 functions: goto[list of terminals] and action[list of non-terminals] in the parsing table. Below is the CLR parsing table

	ACTION			GOTO	
	a	b	$	A	S
0	S3	S4		2	1
1			accept		
2	S6	S7		5	
3	S3	S4		8	
4	R3	R3			
5			R1		
6	S6	S7		9	
7			R3		
8	R2	R2			
9			R2		

LALR(1)

Once we make a CLR parsing table, we can easily make a LALR parsing table from it.

In the step2 diagram, we can see that

- I3 and I6 are similar except their lookaheads.
- I4 and I7 are similar except their lookaheads.
- I8 and I9 are similar except their lookaheads.

In LALR parsing table construction , we merge these similar states.

- Wherever there is 3 or 6, make it 36(combined form)
- Wherever there is 4 or 7, make it 47(combined form)
- Wherever there is 8 or 9, make it 89(combined form)

LALR(1)

- Below is the LALR parsing table.

	ACTION			GOTO	
	a	b	$	A	S
0	S36	S47		2	1
1			accept		
2	S36	S47		5	
36	S36	S47		89	
47	R3	R3			
5			R1		
36	S36	S47		89	
47			R3		
89	R2	R2			
89			R2		

LALR(1)

Now we have to remove the unwanted rows

- As we can see, 36 row has same data twice, so we delete 1 row.
- We combine two 47 row into one by combining each value in the single 47 row.
- We combine two 89 row into one by combining each value in the single 89 row.

LALR(1)

- The final LALR table looks like the below.

	ACTION			GOTO	
	a	b	$	A	S
0	S36	S47		2	1
1			accept		
2	S36	S47		5	
36	S36	S47		89	
47	R3	R3	R3		
5			R1		
89	R2	R2	R2		

END