# LR(1) & LALR(1)

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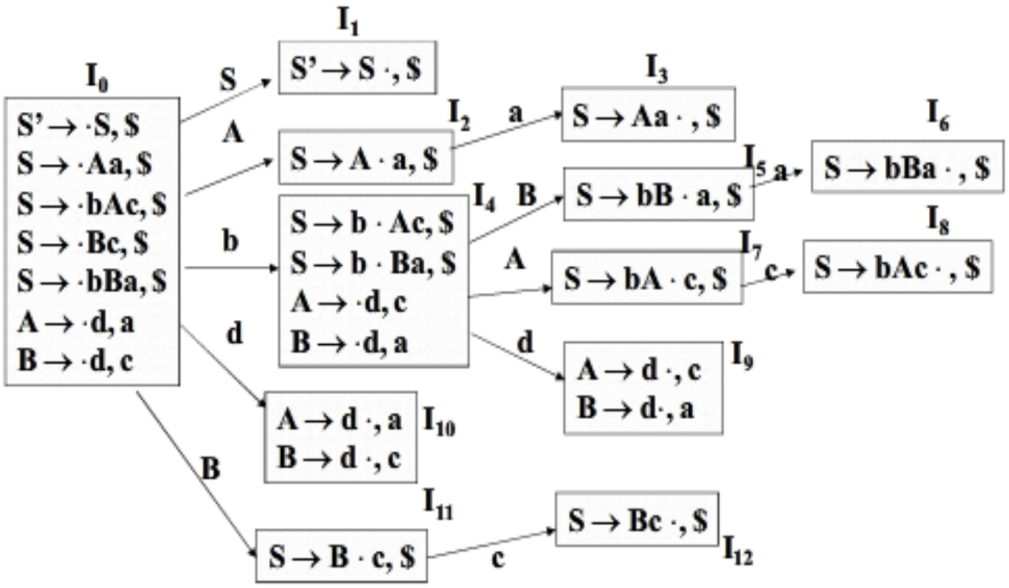
## LR(k)

1. Consider the following grammar

$$S \to A\ a \mid b\ A\ c \mid B\ c \mid b\ B\ a$$
$$A \to d$$
$$B \to d$$

### a) Complete LR(1) states for the grammar


I0
S' → ·S, $
S → ·Aa, $
S → ·bAc, $
S → ·Bc, $
S → ·bBa, $
A → ·d, a
B → ·d, c
S
A
b
d
B
I1
S' → S ·, $
I2
S → A · a, $
I4
S → b · Ac, $
S → b · Ba, $
A → ·d, c
B → ·d, a
A → d ·, a
B → d ·, c
I10
I11
S → B · c, $
I3
S → Aa · , $
I5
S → bB · a, $
I7
S → bA · c, $
I9
A → d ·, c
B → d·, a
I6
S → bBa · , $
I8
S → bAc · , $
I12
S → Bc ·, $
a
B
A
d
a
c
c

**b) Complete LR(1) parsing table for the grammar**

| | a | b | c | d | $ | S | A | B |
|---|---|---|---|---|---|---|---|---|
| **0** | | s4 | | s10 | | 1 | 2 | 11 |
| **1** | | | | | acc | | | |
| **2** | s3 | | | | | | | |
| **3** | | | | | r1 | | | |
| **4** | | | | s9 | | | 7 | 5 |
| **5** | S6 | | | | | | | |
| **6** | | | | | r4 | | | |
| **7** | | | s8 | | | | | |
| **8** | | | | | r2 | | | |
| **9** | r6 | | r5 | | | | | |
| **10** | r5 | | r6 | | | | | |
| **11** | | | s12 | | | | | |
| **12** | | | | | r3 | | | |

## c) Prove the grammar is not LALR(1)

Solution:Proof by contradiction. Suppose this is LALR(1) grammar, then the $state_9$ and $state_{10}$ can be merged to a single state
$A \to d, a/c$
$B \to d, a/c$.
This causes the reduce conflict. Thus, it cannot be a LALR(1) grammar.

## d) Which rule can be substituted and removed to make this grammar LALR(1)?

In fact, either $A \to d$ or $B \to d$ can be substituted and removed. Below is the parsing states for substituting $B \to d$. Clearly, there is no states to be merged. Thus, it is a LALR(1) grammar.