An LR(0) item is a 2-tuple (a pair): (production, dot).
An LR(1) item is a 3-tuple: (production, dot, lookahead).

```
// I is a set of LR(1) items
fn lr1_closure(I) {
    while changed {
        for each item (P, d, a) in I {
            if d == len(P) {
                continue;
            } else if P[d] is a terminal {
                continue;
            } else { // P[d] is a nonterminal {
                for each production Q targeting P[d] {
                    for each terminal b in FIRST(P[d + 1:] + a) {
                        insert(I, (Q, 0, b));
                    }
                }
            }
        }
    }
}
```

$P = A \to X\,Y\,Z\,X\,Y\,Z$

$d = 1$

$P[d] = Y$

$P[d+1:] = ZXYZ$

$P[d+1:] + a = ZXYZa$

```
// I is a LR(1) set of items
// X is a symbol in our grammar
fn lr1_goto(I, X) {
    result = {}
    for (P, d, a) in I {
        if d == len(P) {
            continue;
        } else if P[d] == X {
            insert(result, (P, d + 1, a));
        }
    }
}
```

```
// G is a grammar
fn lr1_compute_states(G) {
    start = closure({ (start' -> start, 0, $) });
    states = { start };
    while changed {
        for state in states {
            for symbol in G {
                next_state = lr1_closure(lr1_goto(state, symbol));
                insert(states, next_state);
            }
        }
    }
}
```

① $S' \to S$ ② $S \to L = R$ ③ $\mid R$ ④ $L \to *R$ ⑤ $\mid id$ ⑥ $R \to L$

$S' \to \cdot S \overset{\varepsilon}{}, \$$

$S \to \cdot L = R, \$ \leftarrow \text{FIRST}(\varepsilon\$) = \text{FIRST}(\$) = \{\$\}$

$S \to \cdot R, \$ \leftarrow$

$L \to \cdot * R, = \leftarrow \text{FIRST}(= R\$) = \{=\}$

$L \to \cdot id, =$

$R \to \cdot L, \$ \leftarrow \text{FIRST}(\$) = \{\$, \cancel{a, b, c}\}$

~~$R \to \cdot L, a$~~

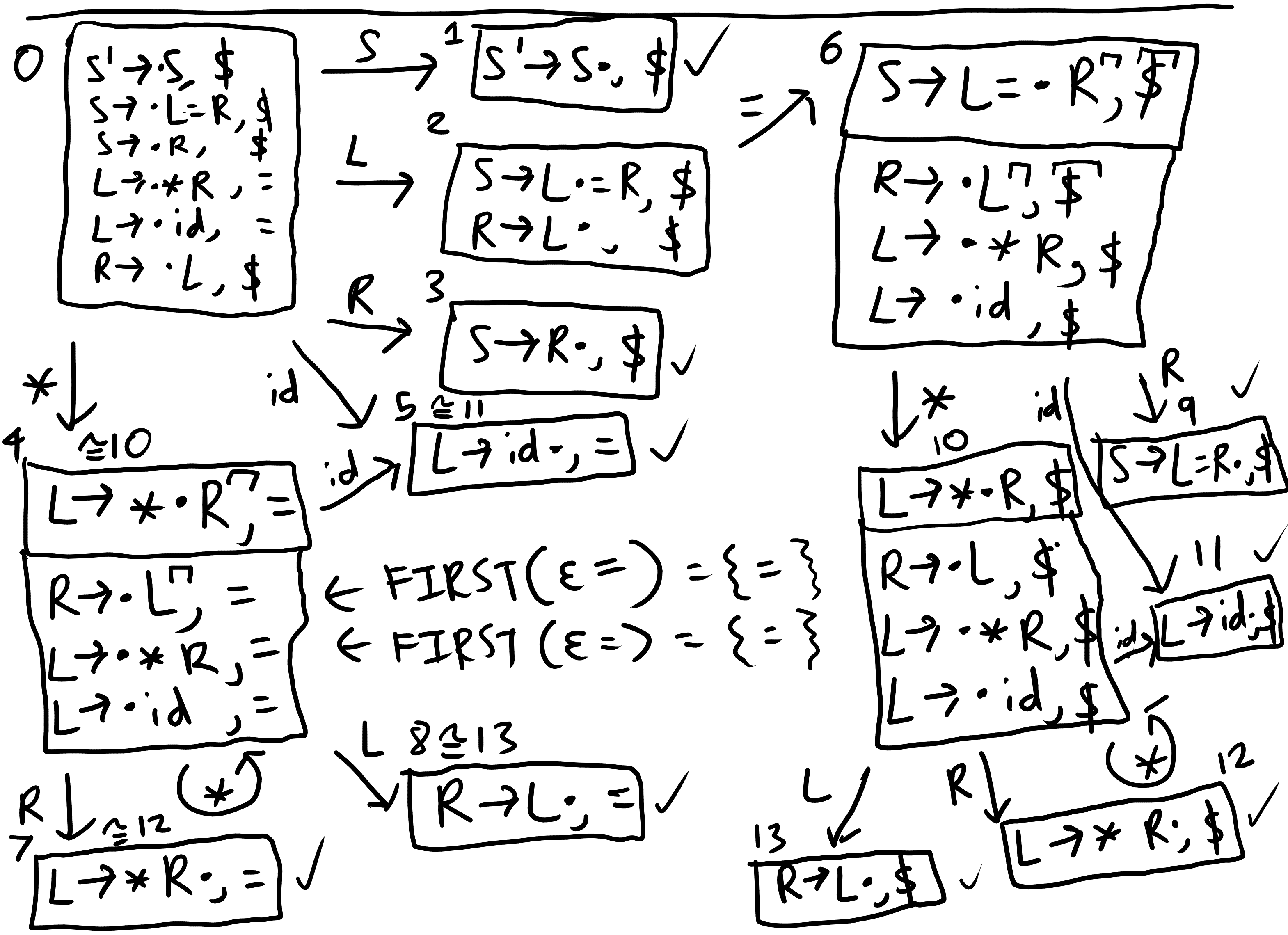
~~$R \to \cdot L, b$~~

~~$R \to \cdot L, c$~~

FIRST(S' or S or L or R) $= *, id$

FOLLOW(S' or S) $= \{\$\}$

FOLLOW(L or R) $= \{\$, =\}$



LALR(1)

$$\overbrace{LR(0) \subsetneq SLR \subsetneq LALR(1)}^{\text{the same \# states}} \subsetneq LR(1)$$

$A \to a\cdot, c$
$B \to b\cdot, d$

$A \to a\cdot, d$
$B \to b\cdot, c$

$A \to a\cdot, c/d \quad \longleftrightarrow \quad A \to a\cdot, c$
$\qquad\qquad\qquad\qquad\qquad\quad A \to a\cdot, d$

$B \to b\cdot, c/d \quad \longleftrightarrow \quad B \to b\cdot, c$
$\qquad\qquad\qquad\qquad\qquad\quad B \to b\cdot, d$

	*	id	=	$	S'	S	L	R
0	s4					1		
1				r1				
2			s6	r6				
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								