CSEN 1003: Compilers

Tutorial 8 - LR(1) and LALR Parsing

Today's Plan

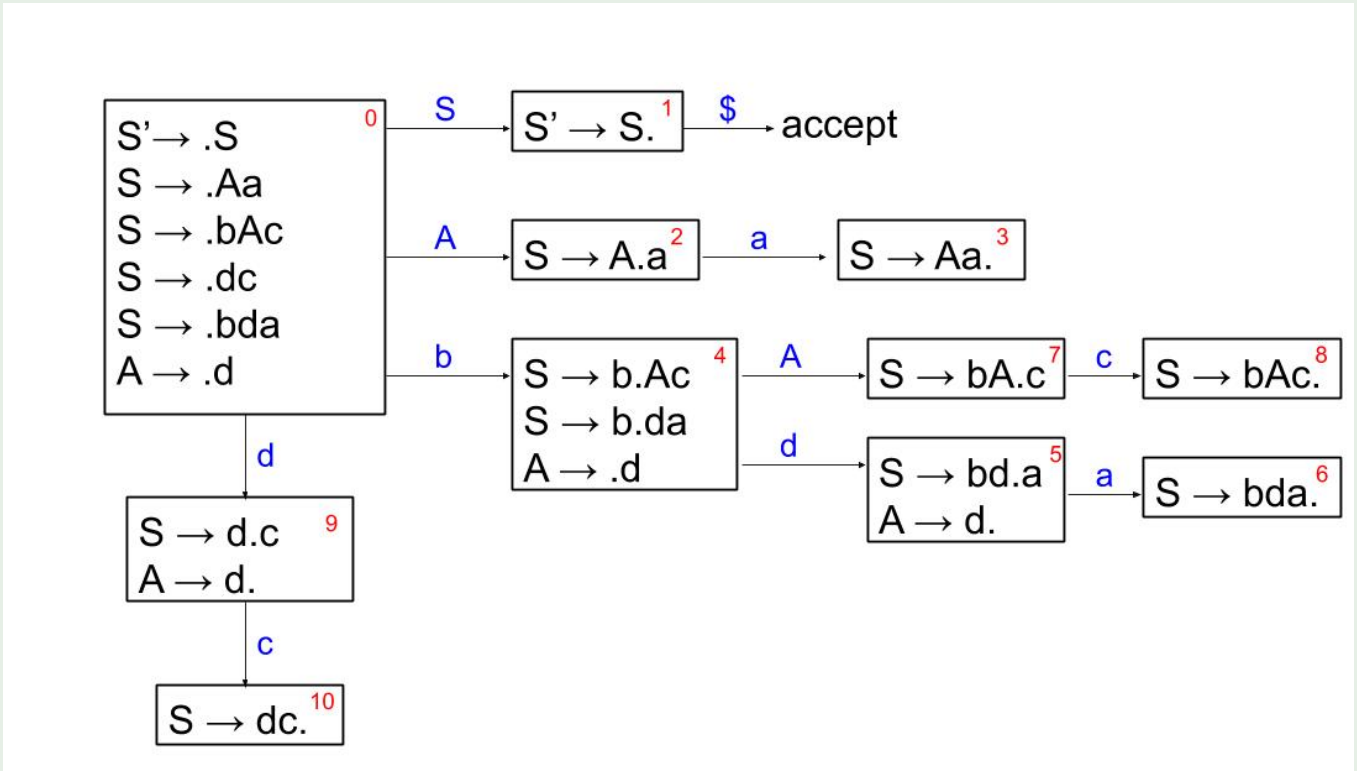
SLR Parsing Conflicts

- SLR Parsing can encounter shift-reduce or reduce-reduce conflicts.
- In particular, it is always possible to reduce according to the SLR parsing table any $A \to \alpha.$ if the next input is in $\mathit{Follow}(A)$.

SLR Parsing Conflicts

Example

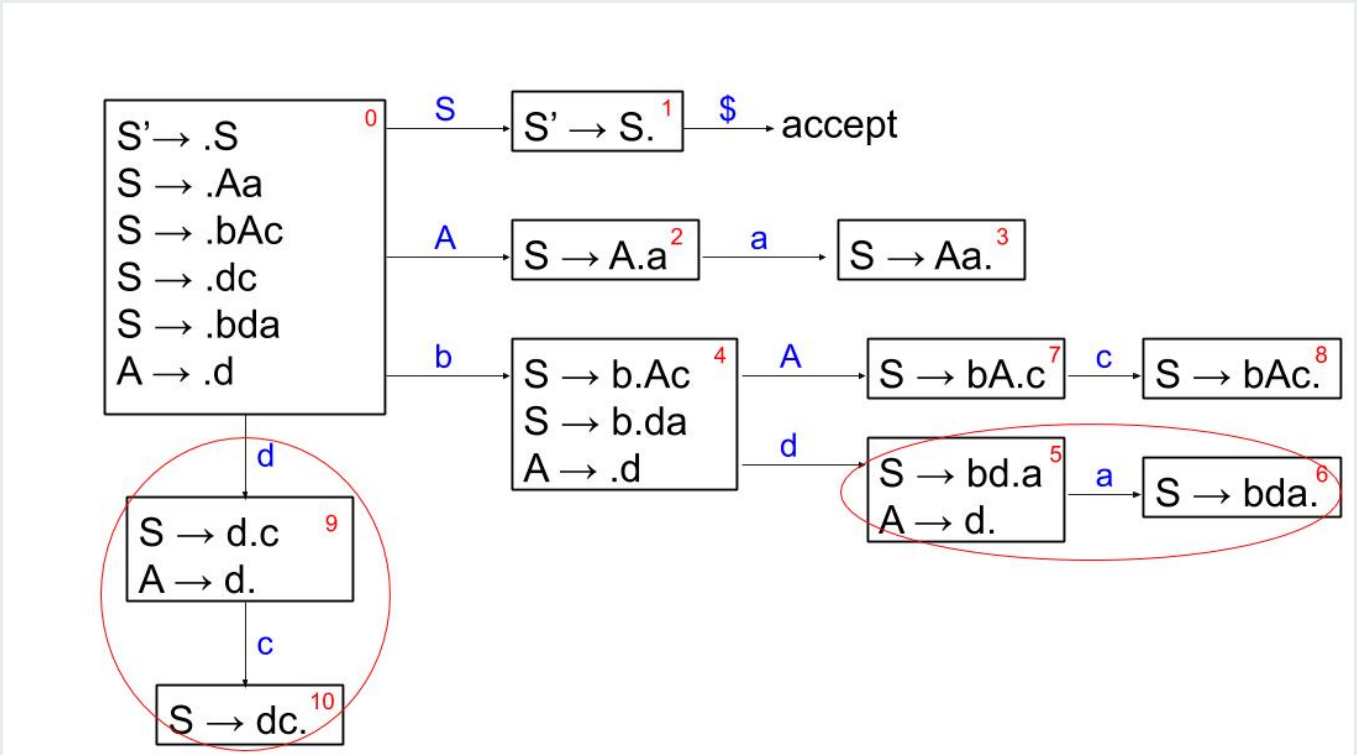
$$S \rightarrow Aa \mid bAc \mid dc \mid bda$$
$$A \rightarrow d$$



SLR Parsing Conflicts

Example

$$S \rightarrow Aa\ (a) \mid bAc\ (b) \mid dc\ (c) \mid bda\ (d)$$
$$A \rightarrow d\ (e)$$



SLR Parsing Table

Example

State	a	b	c	d	$	S	A
5	s6,re		re				
9	re		s10,re				

LR(1) Items

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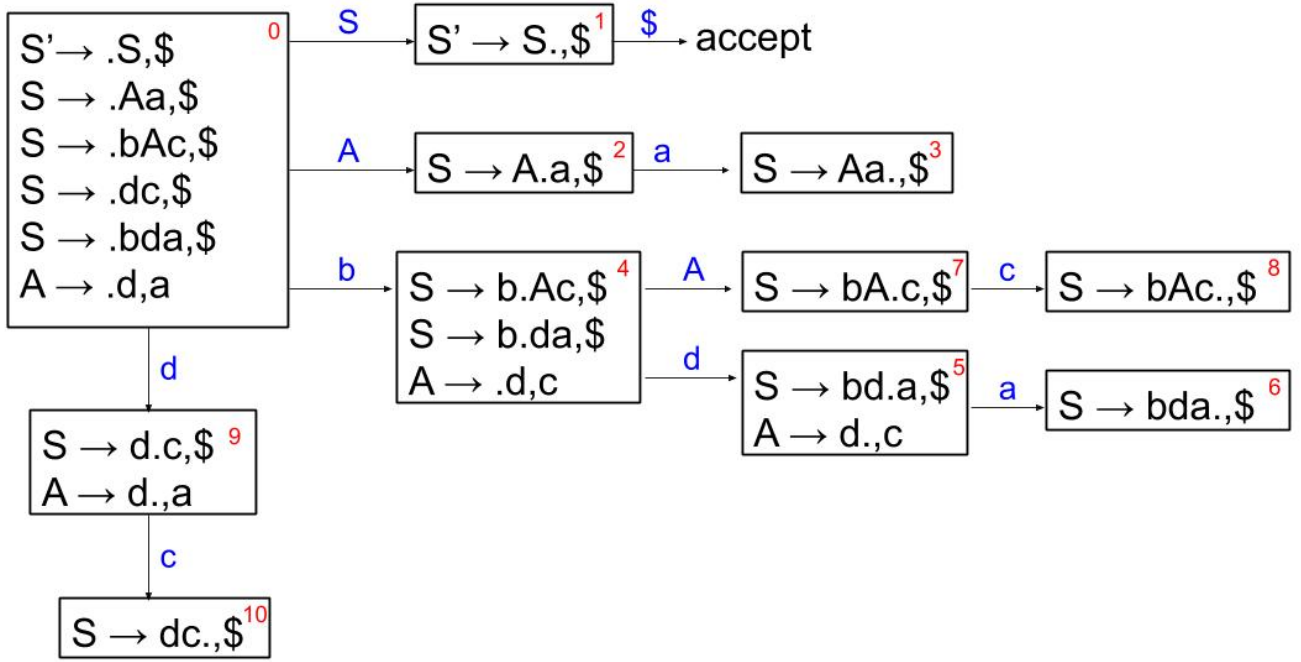
- An LR(1) item $[A \rightarrow \alpha.\beta, a]$ represents a state of the parser where α was found, and if β is found next, the parser may reduce $\alpha\beta$ to A if the next input symbol is a.
- $A \rightarrow \alpha.\beta$ is called the core and a is the lookahead.

Step 1: LR(1) Automaton

Example

$$S \rightarrow Aa\ (a) \mid bAc\ (b) \mid dc\ (c) \mid bda\ (d)$$
$$A \rightarrow d\ (e)$$



Step 2: LR(1) Parsing Table

1. $\forall A \in V,\ GOTO(q, A) = \delta(q, A)$.
2. If $[A \to \alpha.a\beta, X] \in q,\ ACTION(q, a) = shift\ \delta(q, a)$.
3. If $A \neq S'$ and
   $[A \to \alpha., X] \in q,\ ACTION(q, a) = reduce\ A \to \alpha$ where
   ~~$a \in Follow(A)$~~ $[A \to \alpha., a] \in q$.
4. If $[S' \to S., X] \in q,\ ACTION(q, \$) = accept$.

Again the grammar is not LR(1) if the parsing table has atleast one cell with more than one action.

LR(1) Parsing Table

Example

State	a	b	c	d	$	S	A
5	s6		re				
9	re		s10				

- This is an LR(1) grammar (as there are no conflicts).

LR(1) Parsing Table

Example

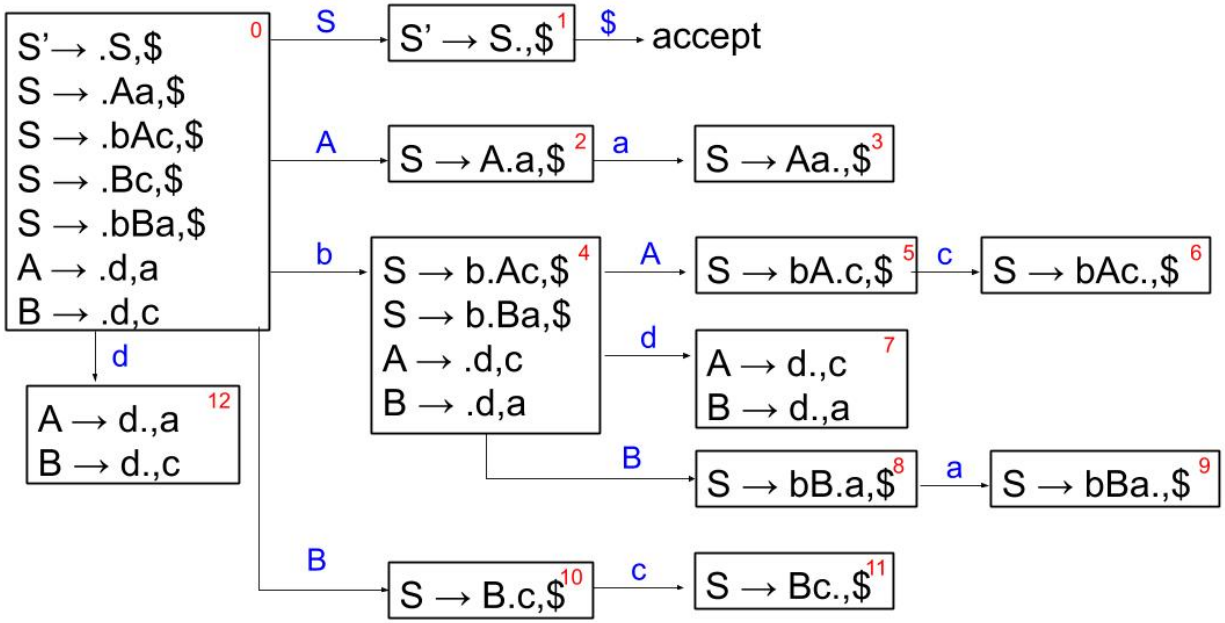
State	a	b	c	d	$	S	A
5	s6		re				
9	re		s10				

- This is an LR(1) grammar (as there are no conflicts).
- But in general, LR(1) parsers have much bigger tables than SLR parsing tables.

LR(1) Parsers

Example

$$
\begin{aligned}
S &\rightarrow Aa\ (a) \mid bAc\ (b) \mid Bc\ (c) \mid bBa\ (d) \\
A &\rightarrow d\ (e) \\
B &\rightarrow d\ (f)
\end{aligned}
$$



Today's Plan

LR(1) Parsers vs LALR Parsers

- To contsruct an LALR parser, we contruct an LR(1) automaton then we combine the core equivalent states.

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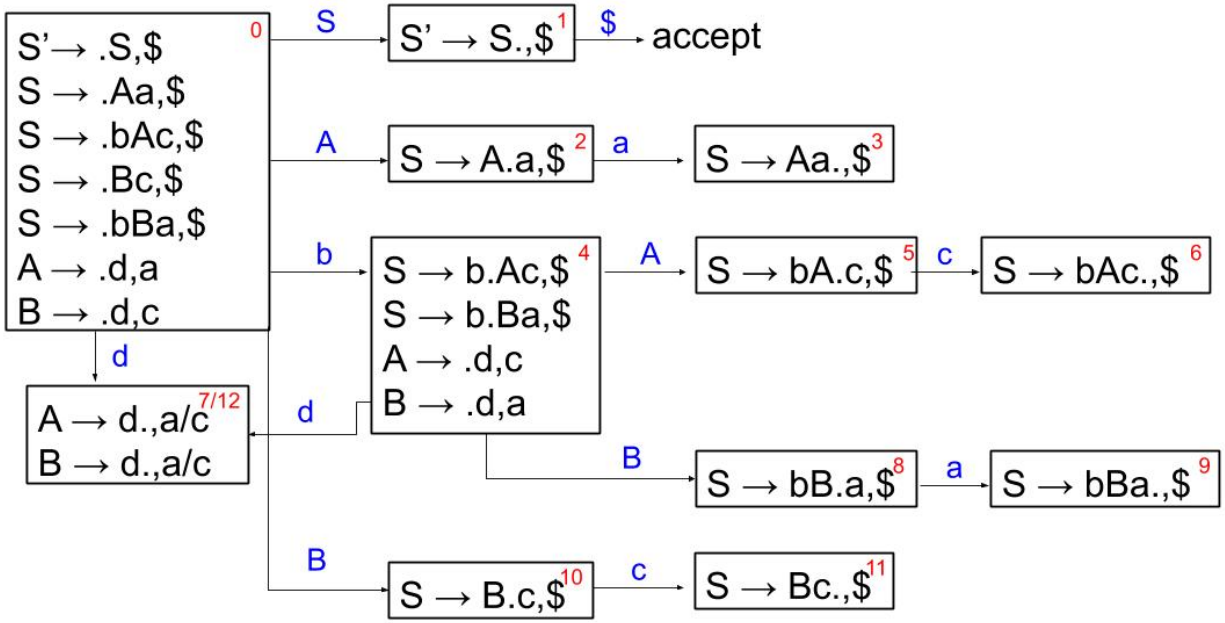
LR(1) Parsers vs LALR Parsers

- To contsruct an LALR parser, we contruct an LR(1) automaton then we combine the core equivalent states.
- LALR tables are typically much smaller.
- Most programming languages use LALR Parsers.

LALR Parsers

Example

$$
\begin{aligned}
S &\rightarrow Aa\ (a) \mid bAc\ (b) \mid Bc\ (c) \mid bBa\ (d) \\
A &\rightarrow d\ (e) \\
B &\rightarrow d\ (f)
\end{aligned}
$$



LALR Parsers

Example

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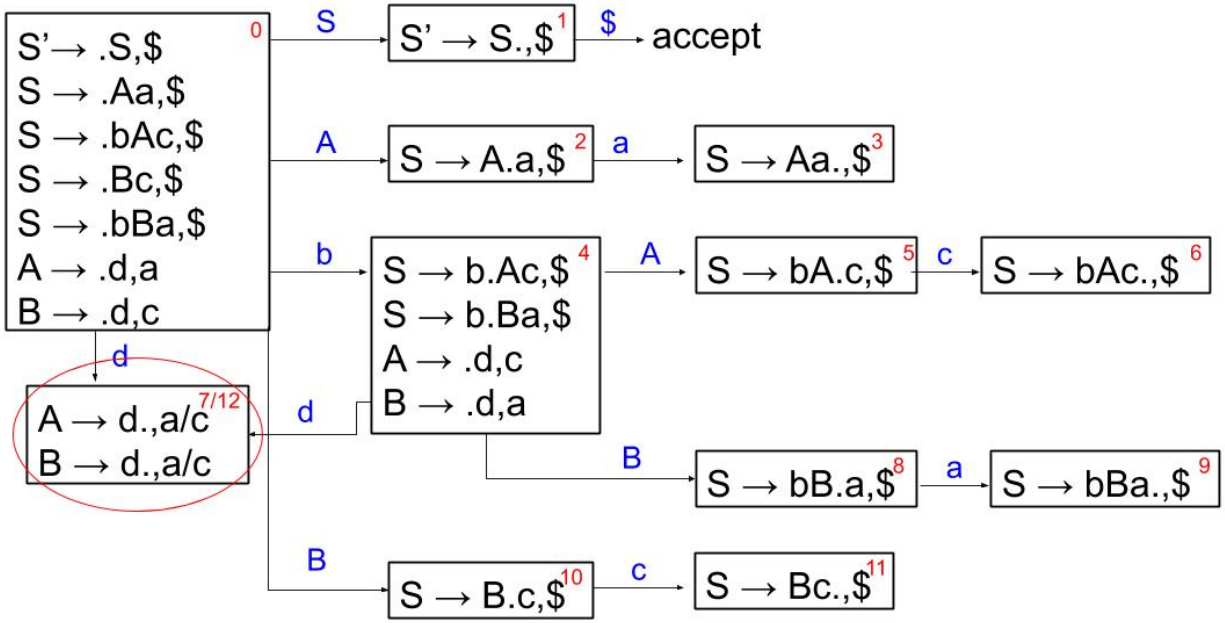

LALR Parsing Table

Example

State	a	b	c	d	$	S	A
7/12	re,rf		re,rf				

LALR Parsing Table

Example

State	a	b	c	d	$	S	A
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- This is not an LALR grammar has the table contains conflicts.
- If LR(1) table has no shift-reduce conflict, so does the LALR table.

LALR Parsing Table

Example

State	a	b	c	d	$	S	A
7/12	re,rf		re,rf				

- This is not an LALR grammar has the table contains conflicts.
- If LR(1) table has no shift-reduce conflict, so does the LALR table.
- However, it might be that case that LR(1) table has no reduce-reduce conflicts, the LALR table might have one!

Today's Plan

Covered Topics

1. LR(1) Parsing.
2. LALR Parsing.

Next Session: Semantic Analysis!