Resolving Conflicts in LALR(1)

- In certain LR(0) states, multiple reductions may be possible.
- Also, reduction and shift might both be possible:
  - Is it OK to take the shift when possible, or is there a problem with the grammar?
- Resolve by computing *lookahead sets* for each item in state that represents possible reduction (dot at end).
- Lookahead set consists of terminal symbols that could legally come next after taking the reduction.
- For item '$Q \rightarrow \ a^{\bullet}$' in state S, is set of all terminals that can follow Q *in an input that puts machine in state* S.
- More precise than FOLLOW set from LL(1) parsing.

Finding Lookaheads

- Idea: try possible reductions and see what shifts are then possible.
- Suppose that in state S_1, two productions $Q \rightarrow \ a$ and $R \rightarrow \ a$ are both possible.
- Look at what will happen if you reduce with $Q \rightarrow \ a$:
  - Trace backwards from S_1 on the a arc, and then forward on Q.
  - Goes to new state S_2.
- What shifts are possible from S_2? Add these to the *lookahead set* for $Q \rightarrow \ a$ in S_1.
- Also consider further reductions from S_2.
- Do for all states and reduction sequences.
- If lookaheads for $Q \rightarrow \ a$ and $R \rightarrow \ a$ are distinct, we can decide which production to take.

Example of LALR(1) Lookaheads

Consider this (silly) grammar and its LR(0) machine (terminals are a, x, y, $\dashv$):

$$
\begin{aligned}
P &\rightarrow S \dashv \\
S &\rightarrow Q\, x \\
S &\rightarrow R\, y \\
Q &\rightarrow a \\
R &\rightarrow a
\end{aligned}
$$

$P \rightarrow \cdot S \dashv$

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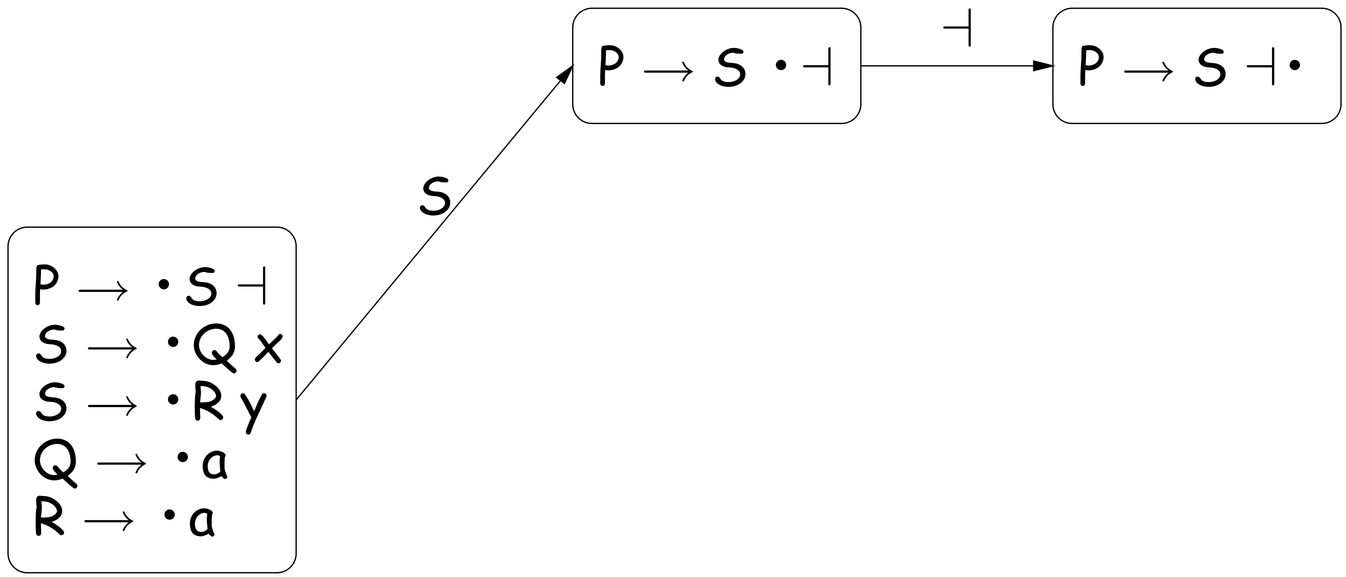

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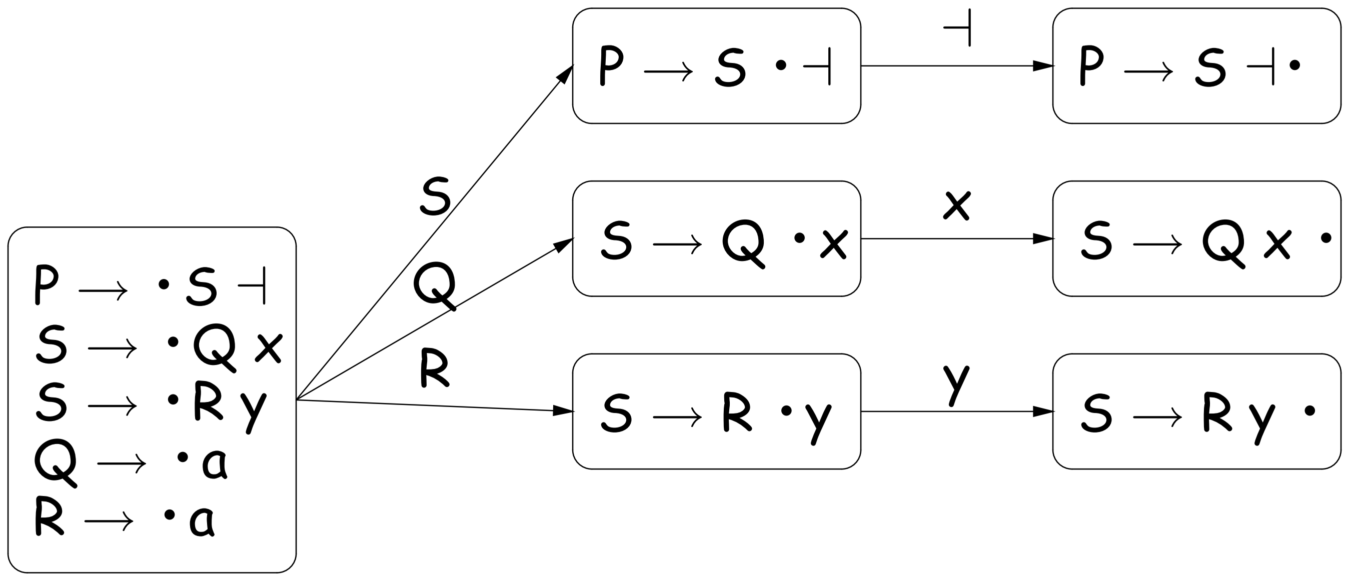

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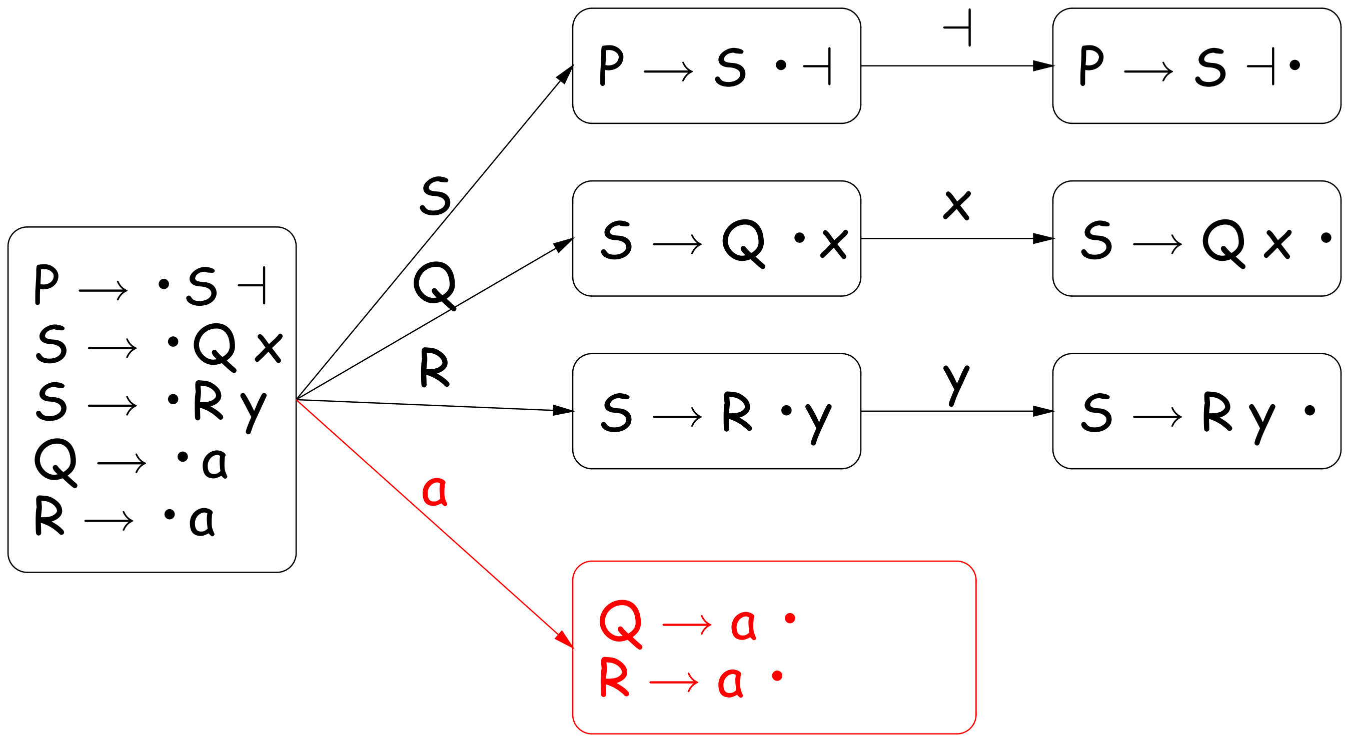

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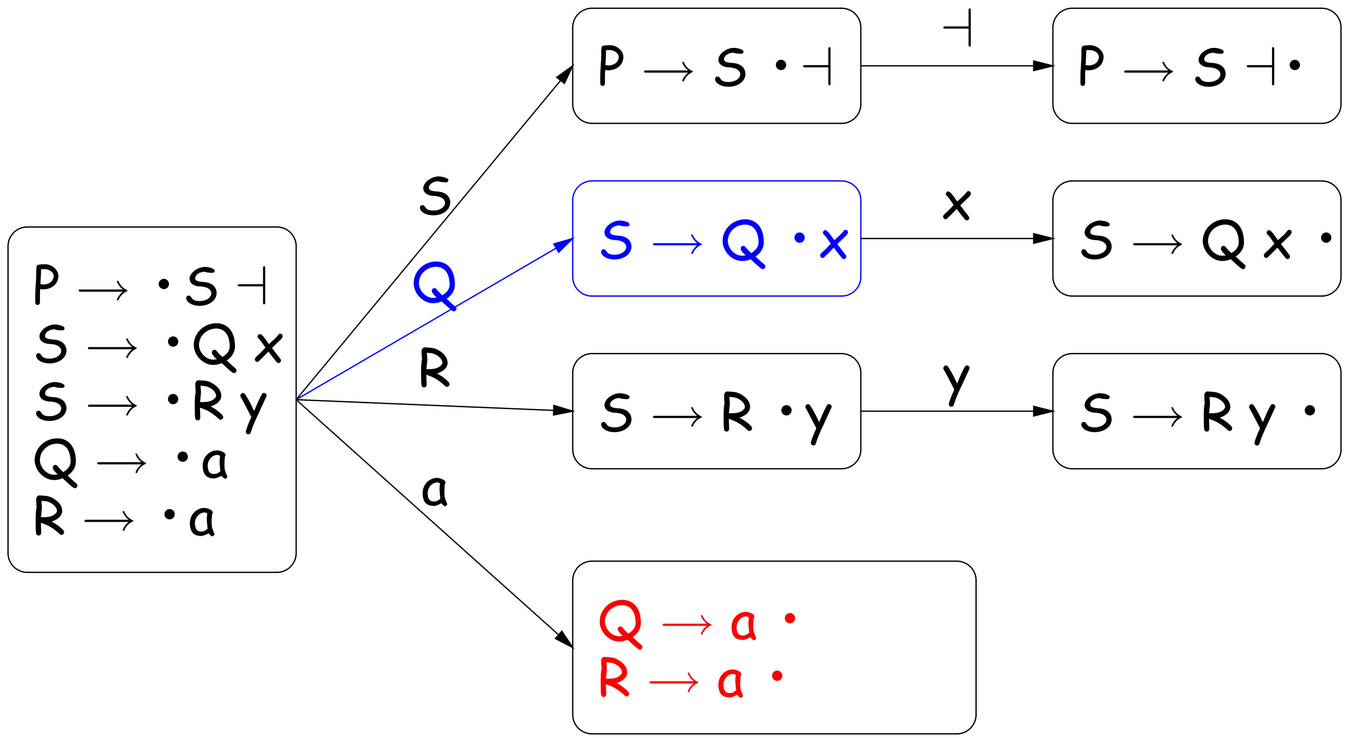

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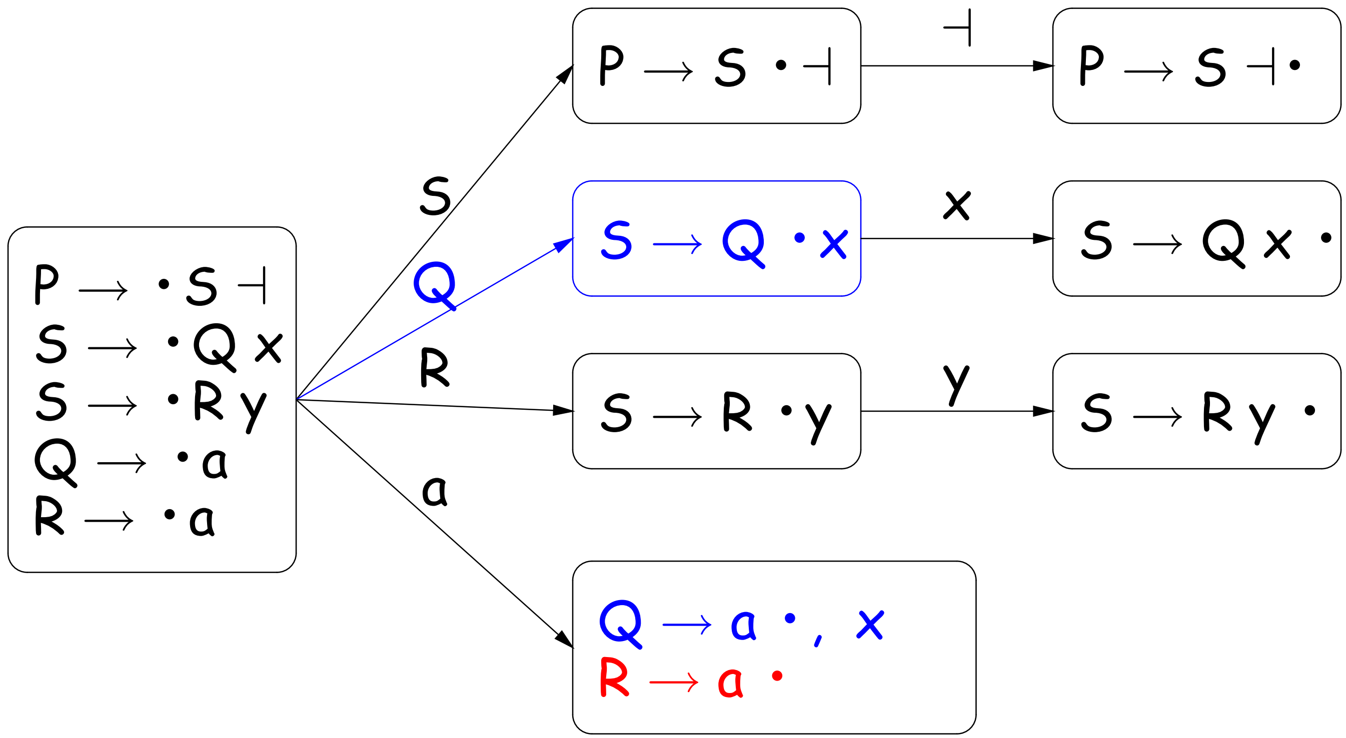

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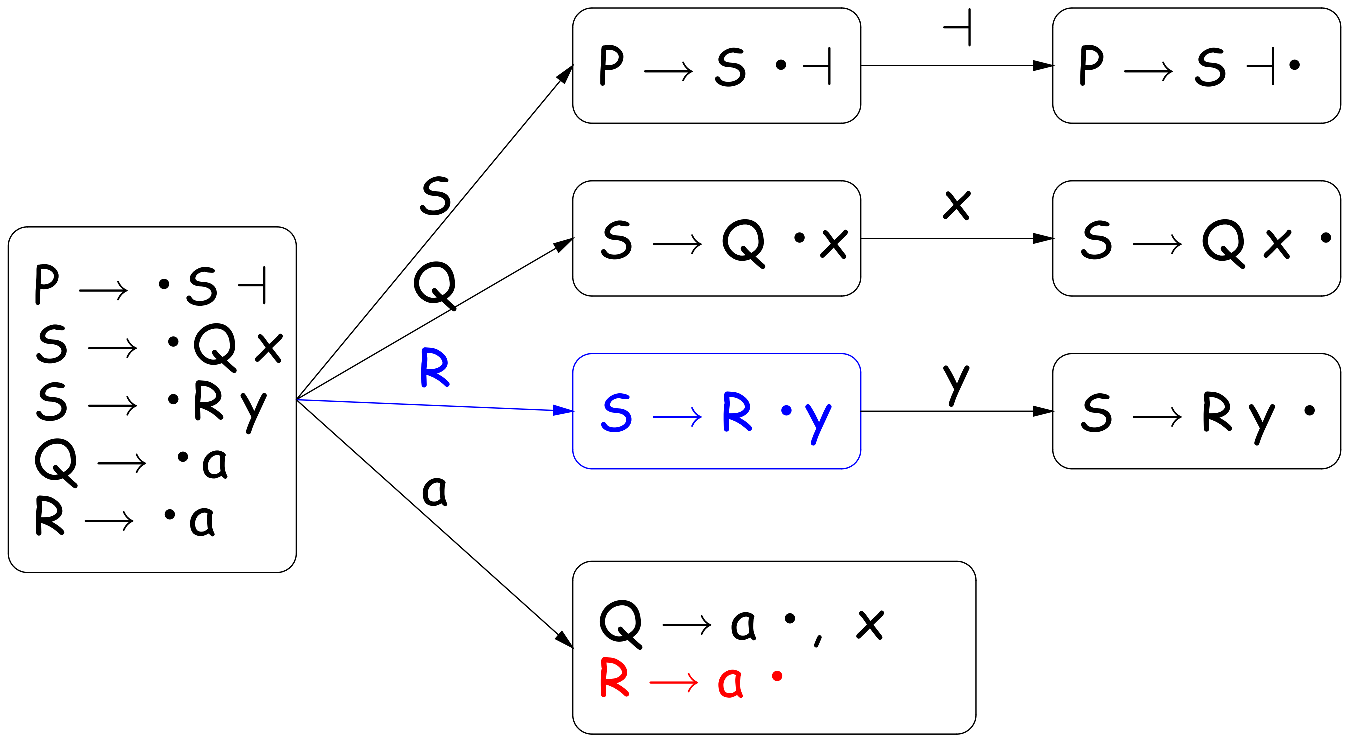

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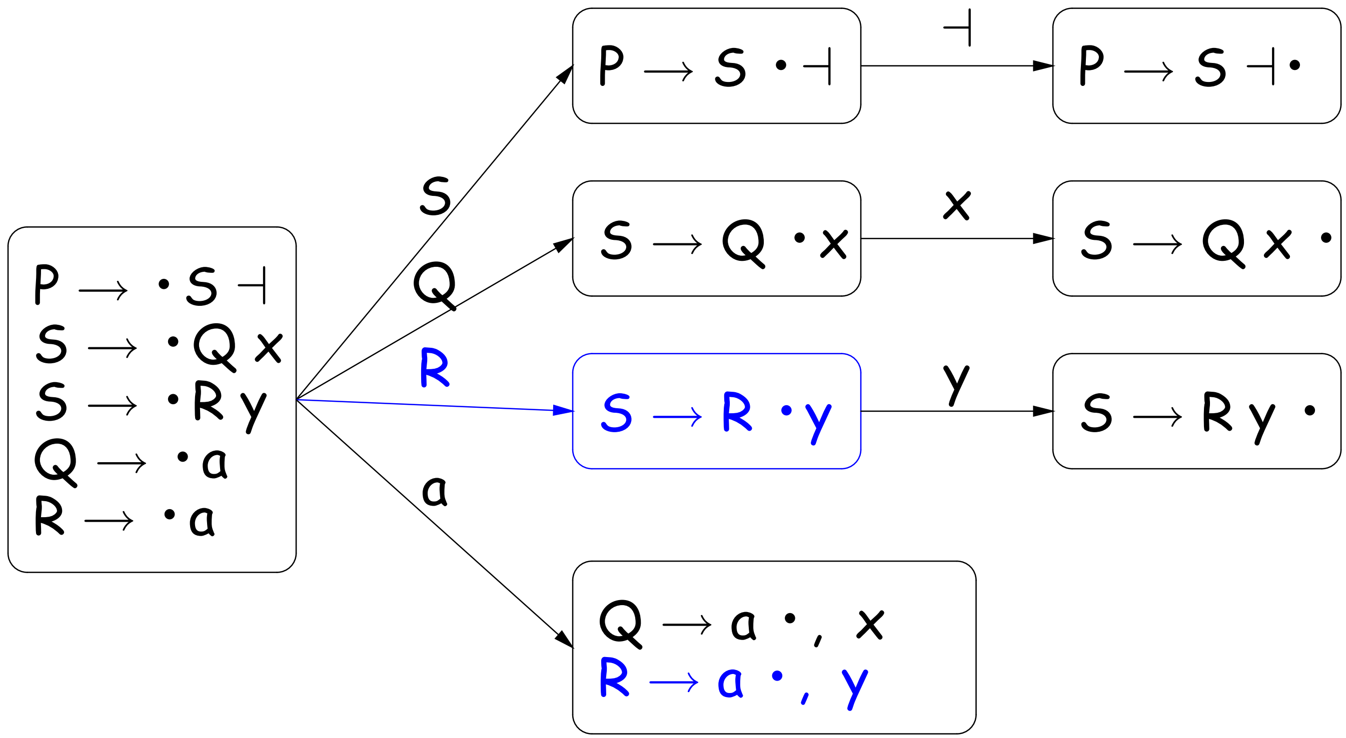

LALR(1) and SLR(1)

- LALR(1) lookahead sets resemble FOLLOW sets.
- In preceding grammar, in fact, could use FOLLOW sets to choose reduction—grammar is SLR(1).
- Not always true. This grammar:

  S $\rightarrow$ A a | b A c | dc | bda
  A $\rightarrow$ d

  has no reduce/reduce conflict, but in the state

  $$b\ d \triangleright c$$

  Must you shift or can you also reduce to A (meaning there is shift/reduce conflict in the grammar)?
- SLR(1) construction won't tell you. LALR(1) will.