



# Compilers

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## SLR Improvements

- Rerunning the viable prefixes automaton on the stack at each step is wasteful
  - Most of the work is repeated

- Remember the state of the automaton on each prefix of the stack
- Change stack to contain pairs  
    ⟨ Symbol, DFA State ⟩

- For a stack

$\langle \text{sym}_1, \text{state}_1 \rangle \dots \langle \text{sym}_n, \text{state}_n \rangle$

$\text{state}_n$  is the final state of the DFA on  $\text{sym}_1 \dots \text{sym}_n$

- Detail: The bottom of the stack is  $\langle \text{any}, \text{start} \rangle$  where
  - $\text{any}$  is any dummy symbol
  - $\text{start}$  is the start state of the DFA

- Define  $\text{goto}[i,A] = j$  if  $\text{state}_i \xrightarrow{A} \text{state}_j$
- $\text{goto}$  is just the transition function of the DFA
  - One of two parsing tables

- Shift  $x$ 
  - Push  $\langle a, x \rangle$  on the stack
  - $a$  is current input
  - $x$  is a DFA state
- Reduce  $X \rightarrow \alpha$ 
  - As before
- Accept
- Error

For each state  $s_i$  and terminal  $a$

- If  $s_i$  has item  $X \rightarrow \alpha.a\beta$  and  $\text{goto}[i,a] = j$  then  $\text{action}[i,a] = \text{shift } j$
- If  $s_i$  has item  $X \rightarrow \alpha.$  and  $a \in \text{Follow}(X)$  and  $X \neq S'$  then  $\text{action}[i,a] = \text{reduce } X \rightarrow \alpha$
- If  $s_i$  has item  $S' \rightarrow S.$  then  $\text{action}[i,\$] = \text{accept}$
- Otherwise,  $\text{action}[i,a] = \text{error}$

Let  $I = w\$$  be initial input

Let  $j = 0$

Let DFA state 1 have item  $S' \rightarrow .S$

Let  $\text{stack} = \langle \text{dummy}, 1 \rangle$

repeat

case  $\text{action}[\text{top\_state}(\text{stack}), I[j]]$  of

shift  $k$ : push  $\langle I[j++], k \rangle$

reduce  $X \rightarrow A$ :

pop  $|A|$  pairs,

push  $\langle X, \text{goto}[\text{top\_state}(\text{stack}), X] \rangle$

accept: halt normally

error: halt and report error



- Note that the algorithm uses only the DFA states and the input
  - The stack symbols are never used!
- However, we still need the symbols for semantic actions

- Some common constructs are not SLR(1)
- LR(1) is more powerful
  - Build lookahead into the items
  - An LR(1) item is a pair: LR(0) item x lookahead
  - $[T \rightarrow \cdot \text{int} * T, \$]$  means
    - After seeing  $T \rightarrow \text{int} * T$  reduce if lookahead is  $\$$
  - More accurate than just using follow sets
  - Take a look at the LR(1) automaton for your parser!