The Overall Procedure I

- Given

$$P = (Q, \Sigma, \Gamma, \delta, q_0, \{q_{accept}\})$$

- Construct a CFG G

$$\text{var}(G) = \{A_{pq} \mid p, q \in Q\}$$

- Start variable:

$$A_{q_0, q_{accept}}$$

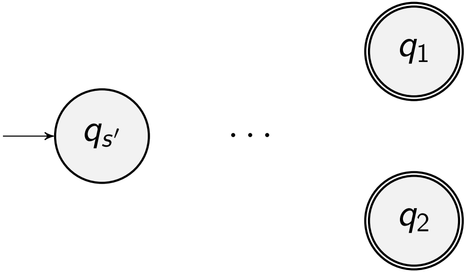
- Rules: see earlier slides

Needed modifications of PDA I

- Recall we need PDA to satisfy
  1. Single accept state
  2. Stack empty before accepting
  3. Each transition push or pop, but not both
- Let's handle the first two together: single accept and stack empty before accepting:
- A new start $q_s \to q_{s'}$ with $\epsilon, \epsilon \to \$$
- For any $q \in F$, we have $\epsilon, a \to \epsilon$ back to q, $\forall a$. This pops things out before accepting a string
- Then from any $q \in F$, we do $\epsilon, \$ \to \epsilon$ to q_a.

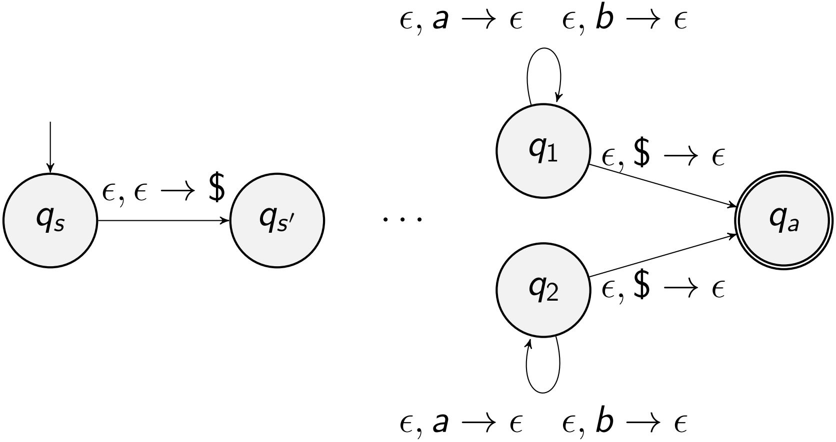
Needed modifications of PDA II

- $q \in F$ are no longer accept states
- See the illustration in the following figures
- Original PDA:



Needed modifications of PDA III

New:



Needed modifications of PDA IV

- To have each transition push or pop, but not both, change

$$q_1 \to q_2 \text{ with } a, a \to b$$

to

$$q_1 \to q_3, a, a \to \epsilon$$
$$q_3 \to q_2, \epsilon, \epsilon \to b$$

and change

$$q_1 \to q_2, a, \epsilon \to \epsilon$$

to

$$q_1 \to q_3, a, \epsilon \to ?$$
$$q_3 \to q_2, \epsilon, ? \to \epsilon$$

Regular language is context Free I

- We roughly know this but didn't give a formal proof. Here are the steps
- Regular language $\Rightarrow$ recognized by DFA (in Chapter 1)
- DFA is a PDA
- Thus regular language recognized by PDA
- Then any regular language is context free (by the proof in this chapter)

Non-context free languages I

- There are such languages
- We omit the discussion