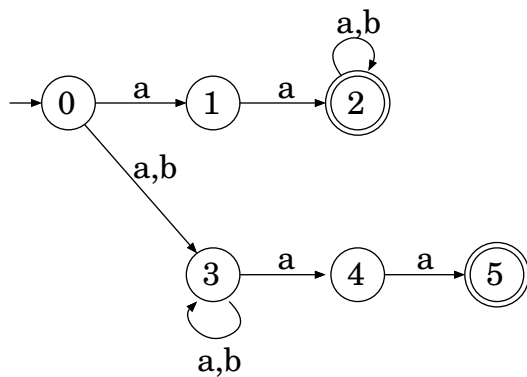


05-0: **YANFAE**¹

- All strings over $\{a,b\}$ that begin or end with aa

¹Yet Another NFA Example 05-1: **YANFAE**¹

- All strings over $\{a,b\}$ that begin or end with aa

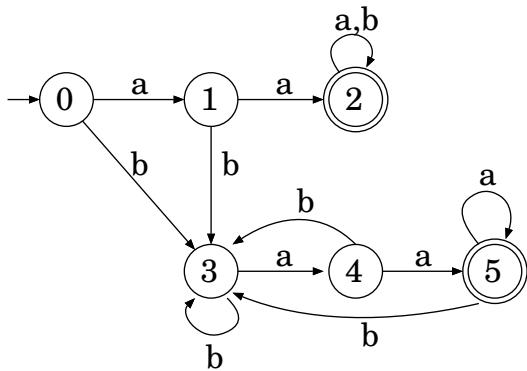


¹Yet Another NFA Example 05-2: **NFA** \rightarrow **DFA**

- Can we create a DFA for the same language?
- All strings over $\{a,b\}$ that begin or end with aa

05-3: **NFA** \rightarrow **DFA**

- Can we create a DFA for the same language?
- All strings over $\{a,b\}$ that begin or end with aa



05-4: L_{NFA} vs L_{DFA}

- What is the relationship between L_{NFA} and L_{DFA} ?
 - $L_{DFA} \subseteq L_{NFA}$
 - Why?

05-5: L_{NFA} vs L_{DFA}

- What is the relationship between L_{NFA} and L_{DFA} ?
 - $L_{DFA} \subseteq L_{NFA}$
 - Every DFA is also an NFA

05-6: L_{NFA} vs L_{DFA}

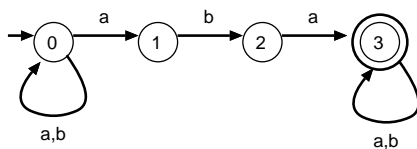
- What is the relationship between L_{NFA} and L_{DFA} ?
 - $L_{DFA} \subset L_{NFA}$?
 - $L_{DFA} \subseteq L_{NFA} \wedge L_{NFA} \subseteq L_{NFA} (L_{NFA} = L_{DFA})$?
- Given any NFA M , can we create a DFA M' such that $L[M] = L[M']$?

05-7: L_{NFA} vs L_{DFA}

- What is the relationship between L_{NFA} and L_{DFA} ?
 - $L_{DFA} \subseteq L_{NFA} \wedge L_{NFA} \subseteq L_{NFA} (L_{NFA} = L_{DFA})$
- Given any NFA M , we *can* create a DFA M' such that $L[M] = L[M']$

05-8: **NFA** \rightarrow **DFA**

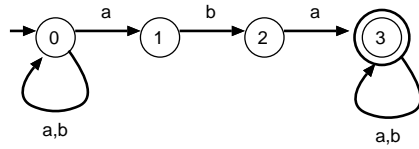
- NFA for all strings over $\{a,b\}$ containing aba



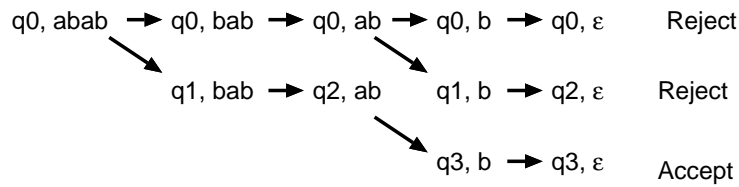
- Trace abab

05-9: NFA → DFA

- NFA for all strings over {a,b} containing aba

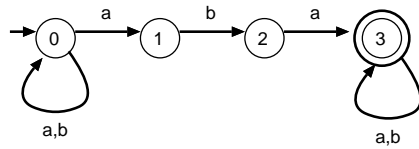


- Trace abab

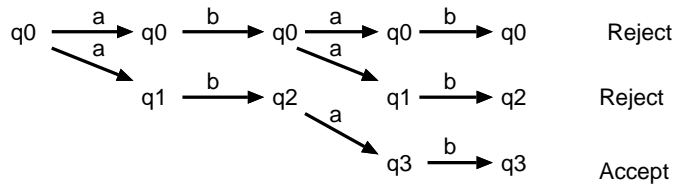


05-10: NFA → DFA

- NFA for all strings over {a,b} containing aba

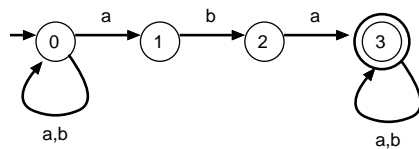


- Trace abab

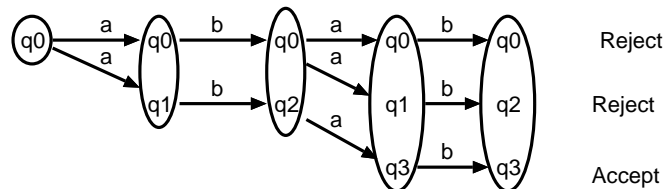


05-11: NFA → DFA

- NFA for all strings over {a,b} containing aba

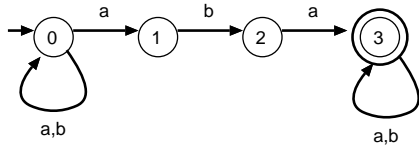


- Trace abab

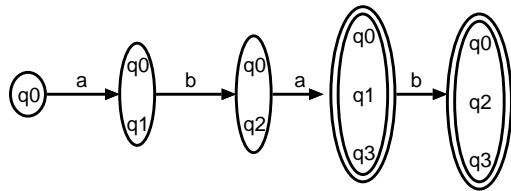


05-12: NFA → DFA

- NFA for all strings over $\{a,b\}$ containing aba

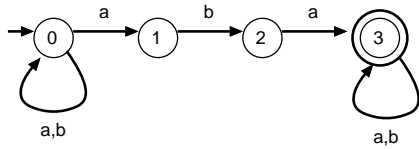


- Trace abab



05-13: NFA → DFA

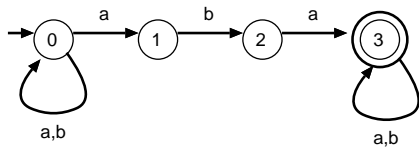
- NFA for all strings over $\{a,b\}$ containing aba



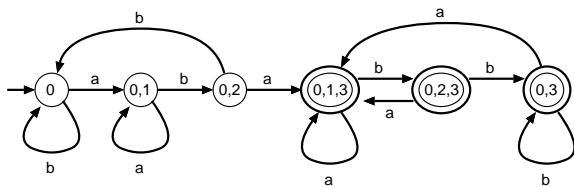
- Build Equivalent DFA

05-14: NFA → DFA

- NFA for all strings over $\{a,b\}$ containing aba



- Build Equivalent DFA



05-15: NFA → DFA

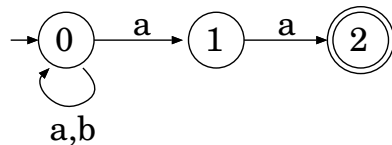
- What about ϵ -transitions?

- $K' =$
- $\Sigma' =$
- $\delta' =$
- $s' =$
- $F' =$

05-20: **Proof:** $L_{NFA} \subseteq L_{DFA}$

- NFA $M = (K, \Sigma, \Delta, s, F)$
- DFA $M' = (K', \Sigma', \delta', s', F')$
 - $K' = 2^K$
 - $\Sigma' = \Sigma$
 - $\delta' = \{((q_1, a), q_2) : q_1 \in K', a \in \Sigma, q_2 = \epsilon\text{-closure}(\{q : (q_3 \in q_1) \wedge ((q_3, a), q) \in \Delta\})\}$
 - $s' = \epsilon\text{-closure}(s)$
 - $F' = \{Q : Q \in 2^K \wedge Q \cap F \neq \emptyset\}$

05-21: **Example:** $L_{NFA} \subseteq L_{DFA}$



- $K = \{q_0, q_1, q_2\}$
- $\Sigma = \{a, b\}$
- $\Delta = ((q_0, a), q_0), ((q_0, a), q_1), ((q_0, b), q_0), ((q_1, a), q_2)$
- $s = q_0$
- $F = \{q_2\}$

05-22: **Example:** $L_{NFA} \subseteq L_{DFA}$

- $K' = \{\{\}, \{q_0\}, \{q_1\}, \{q_2\}, \{q_0, q_1\}, \{q_0, q_2\}, \{q_1, q_2\}, \{q_0, q_1, q_2\}\}$
- $\Sigma' = \{a, b\}$
- $\delta' = \{(\{\{q_0\}, a\}, \{q_0\}), (\{\{q_0\}, b\}, \{q_0\}), (\{\{q_0\}, a\}, \{q_0, q_1\}), (\{\{q_0\}, b\}, \{q_0, q_1\}), (\{\{q_1\}, a\}, \{q_2\}), (\{\{q_1\}, b\}, \{q_2\}), (\{\{q_2\}, a\}, \{q_2\}), (\{\{q_2\}, b\}, \{q_2\}), (\{\{q_0, q_1\}, a\}, \{q_0, q_1, q_2\}), (\{\{q_0, q_1\}, b\}, \{q_0, q_1, q_2\}), (\{\{q_0, q_2\}, a\}, \{q_0, q_1, q_2\}), (\{\{q_0, q_2\}, b\}, \{q_0, q_1, q_2\}), (\{\{q_1, q_2\}, a\}, \{q_0, q_1, q_2\}), (\{\{q_1, q_2\}, b\}, \{q_0, q_1, q_2\}), (\{\{q_0, q_1, q_2\}, a\}, \{q_0, q_1, q_2\}), (\{\{q_0, q_1, q_2\}, b\}, \{q_0, q_1, q_2\})\}$
- $s' = \{q_0\}$
- $F' = \{\{q_2\}, \{q_0, q_2\}, \{q_1, q_2\}, \{q_0, q_1, q_2\}\}$

05-23: **Example:** $L_{NFA} \subseteq L_{DFA}$

