Exercise 3.21.

Consider the following transition table for an NFA with states 1–5, initial state 1 and input alphabet $\{a, b\}$. There are no Λ-transitions:

q	$\delta(q,a)$	$\delta(q,b)$
1	$\{1,2\}$	$\{1\}$
2	$\{3\}$	$\{3\}$
3	$\{4\}$	$\{4\}$
4	$\{5\}$	$\emptyset$
5	$\emptyset$	$\{5\}$

a. Draw a transition diagram of the NFA (note that the accepting states are not specified).

b. Calculate $\delta^*(1, ab)$.
Hint: first calculate $\delta^*(1, \Lambda)$, then $\delta^*(1, a)$, then $\delta^*(1, ab)$.

c. Calculate $\delta^*(1, abaab)$.

Exercise 3.24.

Let $M = (Q, \Sigma, q_0, A, \delta)$ be an NFA with no Λ-transitions. Show that for every $q \in Q$ and every $\sigma \in \Sigma$, $\delta^*(q, \sigma) = \delta(q, \sigma)$.

Exercise 3.33.

Given an example of a regular language L containing Λ that cannot be accepted by any NFA having only one accepting state and no Λ-transitions, and show that your answer is correct.

Exercise 3.22.
A transition table is given for an NFA with seven states.

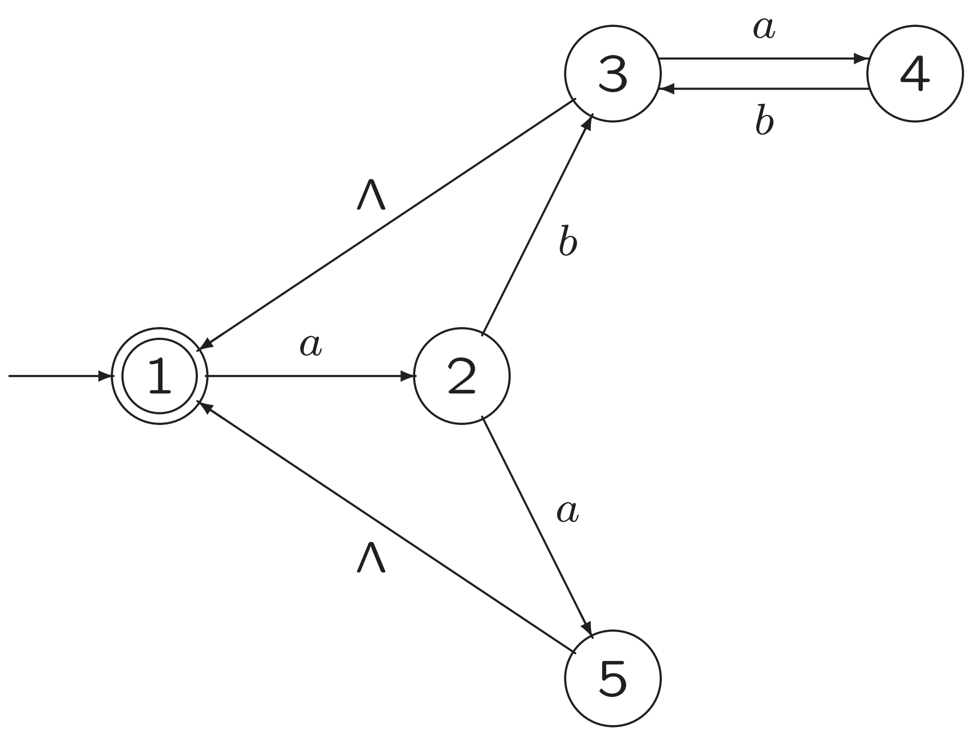
q	$\delta(q,a)$	$\delta(q,b)$	$\delta(q,\Lambda)$
1	$\emptyset$	$\emptyset$	$\{2\}$
2	$\{3\}$	$\emptyset$	$\{5\}$
3	$\emptyset$	$\{4\}$	$\emptyset$
4	$\{4\}$	$\emptyset$	$\{1\}$
5	$\emptyset$	$\{6,7\}$	$\emptyset$
6	$\{5\}$	$\emptyset$	$\emptyset$
7	$\emptyset$	$\emptyset$	$\{1\}$

Find:
d. $\delta^*(1, ba)$
Hint: first calculate $\delta^*(1, \Lambda)$, then $\delta^*(1, b)$, then $\delta^*(1, ba)$.
e. $\delta^*(1, ab)$
f. $\delta^*(1, ababa)$

Exercise 3.37.

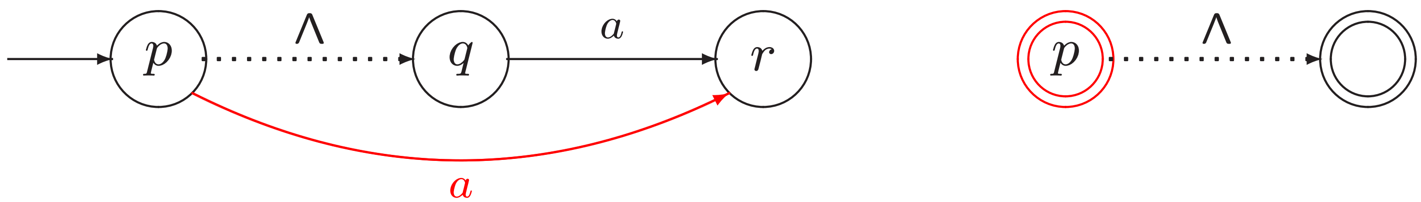
For each part below, use the algorithm from the lecture to draw an NFA with no Λ-transitions accepting the same language as the NFA pictured.

b.



Exercise.

Our construction:



Λ-removal

Given NFA $M = (Q, \Sigma, \delta, q_0, A)$,

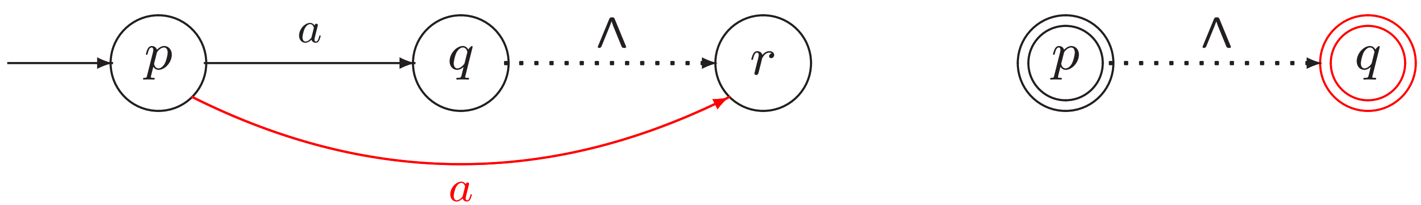
construct NFA $M_1 = (Q, \Sigma, \delta_1, q_0, A_1)$ without Λ-transitions:

- whenever $q \in \Lambda_M(\{p\})$ and $r \in \delta(q, a)$, add r to $\delta_1(p, a)$
- whenever $\Lambda_M(\{p\}) \cap A \neq \emptyset$, add p to A_1.

continued on next slide. . .

Exercise. (ctd.)

Is it possible to invert the construction:



Λ-removal

Given NFA $M = (Q, \Sigma, \delta, q_0, A)$,

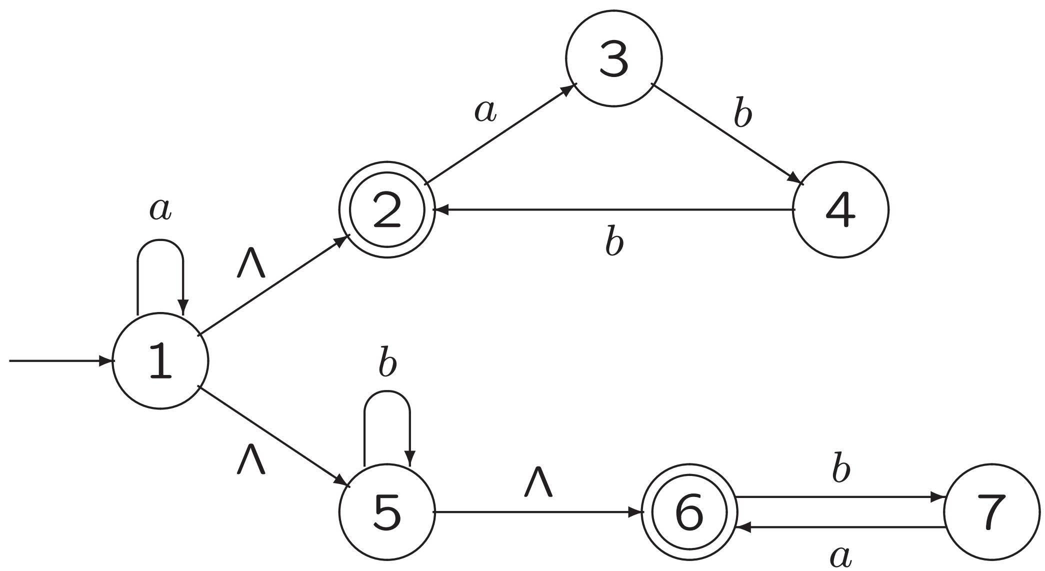
construct NFA $M_1 = (Q, \Sigma, \delta_1, q_0, A_1)$ without Λ-transitions:

- whenever $q \in \delta(p, a)$ and $r \in \Lambda_M(\{q\})$, add r to $\delta_1(p, a)$
- whenever $p \in A$ and $q \in \Lambda_M(\{p\})$, add q to A_1.

Exercise 3.40.

For each part below, draw an FA accepting the same language as the NFA shown.

a.



Exercise 3.32.

Let $M = (Q, \Sigma, q_0, A, \delta)$ be an NFA accepting a language L. Assume that there are no transitions to q_0, that A has only one element, q_f, and that there are not transitions from q_f.

a. Let M_1 be obtained from M by adding Λ-transitions from q_0 to every state that is reachable from q_0 in M.
(If p and q are states, q is reachable from p if there is a string $x \in \Sigma^*$ such that $q \in \delta^*(p, x)$.)
Describe (in terms of L) the language accepted by M_1.

b. Let M_2 be obtained from M by adding Λ-transitions to q_f from every state from which q_f is reachable in M.
Describe (in terms of L) the language accepted by M_2.

c. Let M_3 be obtained from M by adding both the Λ-transitions in (a) and those in (b).
Describe (in terms of L) the language accepted by M_3.