Definition of GNFA I

- Between any two states: a regular expression
- \((Q, \Sigma, \delta, q_{\text{start}}, q_{\text{accept}})\)

\[
\delta : (Q - \{q_{\text{accept}}\}) \times (Q - \{q_{\text{start}}\}) \rightarrow R
\]

\(R\): all regular expressions over \(\Sigma\)

- DFA \(\rightarrow\) GNFA
- Two new states: \(q_{\text{start}}, q_{\text{accept}}\)
  - \(q_{\text{start}} \rightarrow q_0\) with \(\epsilon\)
  - any \(q \in F \rightarrow q_{\text{accept}}\) with \(\epsilon\)
Definition of GNFA II

In the definition, between any two states there is an expression.

But what if in the graph two states are not connected?

$\emptyset \in R$ so if no connection, we simply consider $\emptyset$ as the expression between two states.
GNFA $\rightarrow$ regular expression I

- Fig 1.63
GNFA $\rightarrow$ regular expression II

$q_i$ \( (R_1)(R_2)^* (R_3) \cup (R_4) \) \( q_j \)

- \( q_{rip} \) is the state being removed
- In the procedure
  3-state DFA $\rightarrow$ 5-state GNFA $\rightarrow$ 4-state $\cdots$ $\rightarrow$
  2-state GNFA $\rightarrow$ regular expression
- In the procedure any any \((i, j)\) related to \( q_{rip} \) considered
- Algorithm: convert(G)
  - \( k: \# \) of G
If $k = 2$

return $R$

If $k > 2$, choose any $q_{\text{rip}} \in Q \setminus \{q_s, q_a\}$ for removal

$Q' = Q - \{q_{\text{rip}}\}$

$\forall q_i \in Q' - \{q_{\text{accept}}\}, q_j \in Q' - \{q_{\text{start}}\}$

$\delta'(q_i, q_j) = R_1 R_2^* R_3 \cup R_4,$

where

$R_1 = \delta(q_i, q_{\text{rip}}), R_2 = \delta(q_{\text{rip}}, q_{\text{rip}}),$  
$R_3 = \delta(q_{\text{rip}}, q_j), R_4 = \delta(q_i, q_j)$
4 Run $\text{convert}(G')$, where

$$G' = (Q', \Sigma, \delta', q_s, q_a)$$

Why in the textbook we modify DFA to GNFA?
Is it ok to use NFA?
Seems ok??