Definition of GNFA I

- Here we give the formal definition of generalized NFA
- Between any two states: a regular expression
- $(Q, \Sigma, \delta, q_{start}, q_{accept})$
- Single accept state. No longer a set F
- The δ function:

  $$(Q - \{q_{accept}\}) \times (Q - \{q_{start}\}) \to R$$

  R: all regular expressions over Σ
- DFA $\to$ GNFA

Definition of GNFA II

Two new states: q_{start}, q_{accept}

$$q_{start} \rightarrow q_0 \text{ with } \epsilon$$
$$\text{any } q \in F \rightarrow q_{accept} \text{ with } \epsilon$$

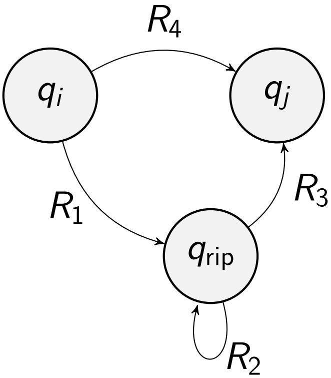
- In the definition, between any two states there is an expression

  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

- q_{rip} is the state being removed



- The new regular expression between q_i and q_j is

GNFA $\rightarrow$ regular expression II

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

- In our example
  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)
  1. k: # of G
  2. If $k = 2$

GNFA $\rightarrow$ regular expression III

$$\text{return } R \text{ between } q_s \text{ and } q_a$$

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

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

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

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

where

$$R_1 = \delta(q_i, q_{\text{rip}}), R_2 = \delta(q_{\text{rip}}, q_{\text{rip}}),$$
$$R_3 = \delta(q_{\text{rip}}, q_j), R_4 = \delta(q_i, q_j)$$

GNFA $\rightarrow$ regular expression IV

4. Run convert(G'), where

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

- You can see we have a recursive setting

  The process stops when $k = 2$
- Why in the textbook we modify DFA to GNFA?

  Is it ok to use NFA?

  Seems ok??