Challenge Activity 1 – DFAs, NFAs, and ε-NFAs

In order to diminish the size and to speed-up the processing of ε-NFAs (especially the ones obtained by the scheme to convert regular expressions to ε-NFAs), a team intends to remove ε transitions from the ε-NFAs.

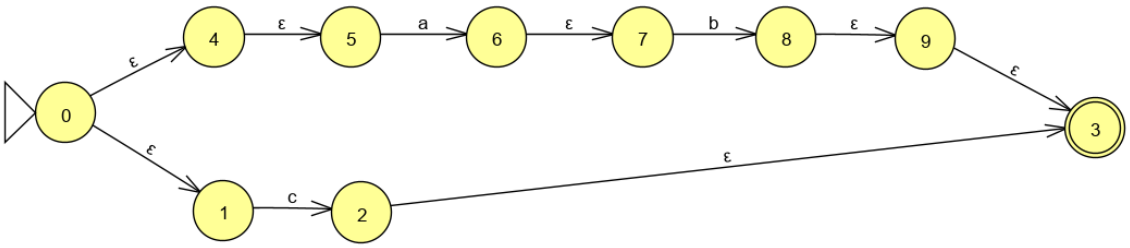
The team suggested the following two-step (A and B, and with first application of A and then of B) scheme to remove the ε-transitions:

A. *While there are modifications in the FA:*
- *For each pair of states (qi, qj) with a single transition, an ε-transition, from qi to qj, only a single input transition to qi and a single output transition from qj, merge the two states in one state qi-qj (the transition from qj becomes transition from qi-qj; and the transition to qi becomes transition to qi-qj).*

B. *While there are modifications in the FA:*
- *for each $\delta(qi, \varepsilon) = \{qj\}$ and $qi \neq qj$, merge qi-qj (qi becomes qi-qj and the transitions from qi and from qj become transitions from qi-qj; and the transitions to qi and qj become transitions to qi-qj, then qj and its transitions are removed from the FA in the case of the only transition from qi and qj is the ε-transition).*

For both steps A and B, if qi is the initial state then qi-qj becomes the initial state. qi-qj becomes a final state if qi or qj are final states.

2. Consider the following input ε-NFA (obtained from the regular expression c+ab):



   a) Apply the A-step of the scheme to the ε-NFA and show the resultant FA. Is the new FA equivalent to the ε-NFA?
   b) Apply the B-step of the scheme to the FA resultant from the A-step and show the new FA. Is the new FA equivalent to the original ε-NFA?
   c) Is proposed scheme valid for any input ε-NFA? Justify your answer.

3. The team, instead of proving the validity of the transformation for any ε-NFA, decided, each time the transformation is used, to verify the equivalence between the two FAs (the input and the output ones) by using a program specially developed for that. Suggest the main steps involved in the verification process of that program.