Government College of Engineering, Jalgaon

(An Autonomous Institute of Govt. of Maharashtra)

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Date of Performance: **Date of completion:**

Experiment No.: Group B: 05

Title: Implement Deterministic Finite Automata.

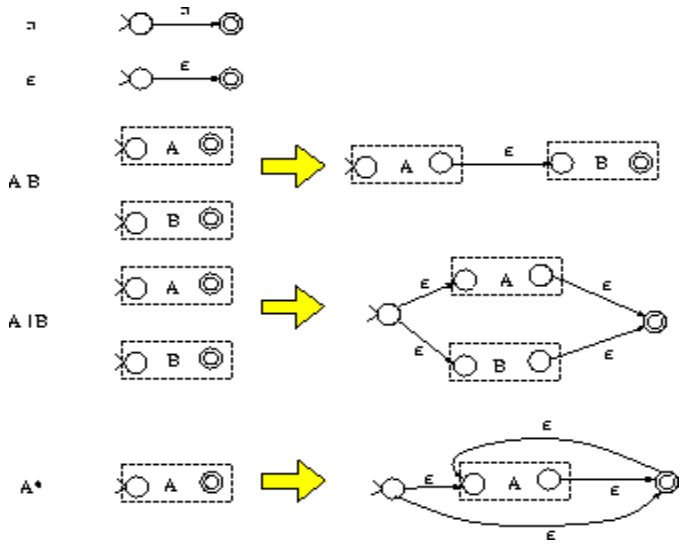
Theory:

The task of a scanner generator, such as flex, is to generate the transition tables or to synthesize the scanner program given a scanner specification (in the form of a set of REs). So it needs to convert a RE into a DFA. This is accomplished in two steps: first it converts a RE into a non-deterministic finite automaton (NFA) and then it converts the NFA into a DFA.

A NFA is similar to a DFA but it also permits multiple transitions over the same character and transitions over ε. The first type indicates that, when reading the common character associated with these transitions, we have more than one choice; the NFA succeeds if at least one of these choices succeeds. The ε transition doesn't consume any input characters, so you may jump to another state for free.

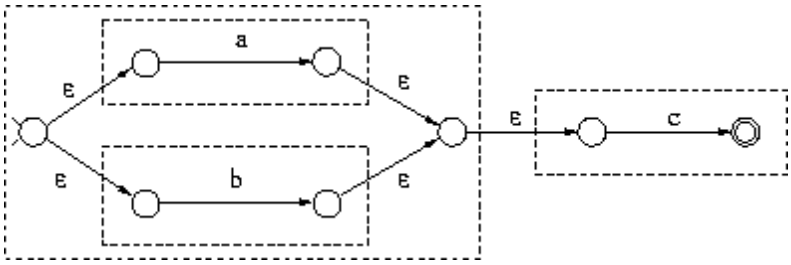
Clearly DFAs are a subset of NFAs. But it turns out that DFAs and NFAs have the same expressive power. The problem is that when converting a NFA to a DFA we may get an exponential blowup in the number of states.

We will first learn how to convert a RE into a NFA. This is the easy part. There are only 5 rules, one for each type of RE:



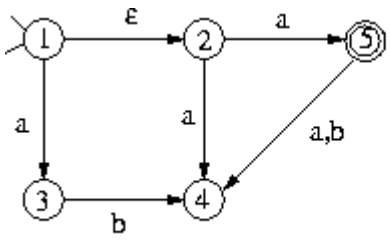
The algorithm constructs NFAs with only one final state. For example, the third rule indicates that, to construct the NFA for the RE *AB*, we construct the NFAs for *A* and *B* which are represented as two boxes with one start and one final state for each box. Then the NFA for *AB* is constructed by connecting the final state of *A* to the start state of *B* using an empty transition.

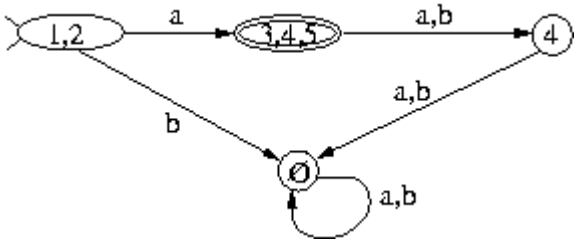
For example, the RE (*a*|b)*c* is mapped to the following NFA:



The next step is to convert a NFA to a DFA (called *subset construction*). Suppose that you assign a number to each NFA state. The DFA states generated by subset construction have sets of numbers, instead of just one number. For example, a DFA state may have been assigned the set {5,6,8}. This indicates that arriving to the state labeled {5,6,8} in the DFA is the same as arriving to the state 5, the state 6, or the state 8 in the NFA when parsing the same input. (Recall that a particular input sequence when parsed by a DFA, leads to a unique state, while when parsed by a NFA it may lead to multiple states.)

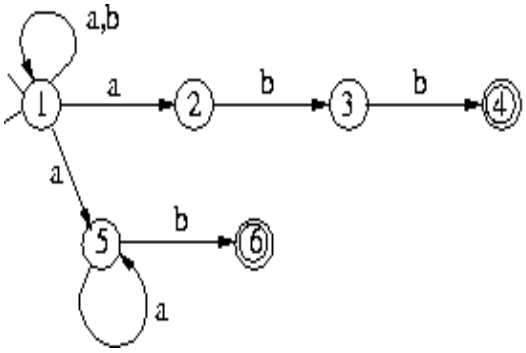
First we need to handle transitions that lead to other states for free (without consuming any input). These are the ε transitions. We define the *closure* of a NFA node as the set of all the nodes reachable by this node using zero, one, or more ε transitions. For example, The closure of node 1 in the left figure below

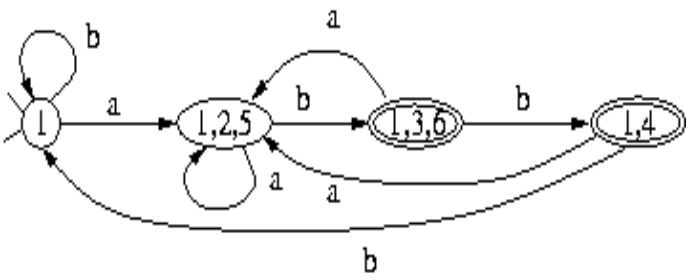




is the set {1,2}. The start state of the constructed DFA is labeled by the closure of the NFA start state. For every DFA state labeled by some set $\{s_1, \ldots, s_n\}$ and for every character *c* in the language alphabet, you find all the states reachable by s_1, s_2, ..., or s_n using *c* arrows and you union together the closures of these nodes. If this set is not the label of any other node in the DFA constructed so far, you create a new DFA node with this label. For example, node {1,2} in the DFA above has an arrow to a {3,4,5} for the character *a* since the NFA node 3 can be reached by 1 on *a* and nodes 4 and 5 can be reached by 2. The *b*arrow for node {1,2} goes to the error node which is associated with an empty set of NFA nodes.

The following NFA recognizes $(a|b)^*(abb|a^+b)$, even though it wasn't constructed with the 5 RE-to-NFA rules. It has the following DFA:





Result:

Thus the program for implementing the Definite Finite Automata was executed and the output was verified successfully.

Course Teacher

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