

Reverse a DFA Using an NFA

CS-461: Theory of Computation (Fall 2015)

Overview

Find the reverse of a language. That is, find a machine that reverses M , a DFA. This is a two stage process. First, build N , an NFA. Second, convert N to R , a DFA which is the reverse of M .

STAGE ONE: Build N , an NFA

1. Copy states from M to N . Create the states of N , exactly the same as the states of M .
2. Add a new start state. Specifically, add a new state, s , the start state of N , and draw epsilon-arrows from s to all states in N that were accepting states in M .
3. Add "reverse arrows" between the states of N . That is, add arrows in N that are the same as those in M , except pointing in the opposite direction. Naturally, looping arrows will still loop the same as before.
4. Make the start state the end state. That is, set accepting state of N to be the state that was the start state of M .
5. Now you have an NFA, N , that reverses the DFA, M .

STAGE TWO: Convert N to R , a DFA which is the reverse of M .

6. To create R , first copy the start state, s , from N .
7. Next, create a new state, $NULL$. On the $NULL$ state, add a loop arrow for all symbols in the alphabet.
8. Starting from the start state, s , make "combo states." Create a combo state for each transition possibility of a symbol from a state, including the symbol with epsilon. Draw arrows from state to state as appropriate. ¹
9. Repeat step 8 until all possibilities are enumerated. Another way to do this is to create a transition table where the left hand column is the power set of the states in N and the other columns are the symbols in the alphabet (excluding epsilon).
10. Set accepting states of R to be any state containing accepting state of N .
11. Now you have a DFA, R , that reverses the language of the DFA, M . (This may or may not be a "fully reduced machine," i.e. a machine with the minimal number of states. But it will be a DFA.)

End

¹ For example, if using the symbol "a" in N it is possible to transition from the start state to states 1 or 2 and with epsilon to state 3, then the combo state would be "1, 2, 3." The arrow for "a" would go from "s" to "1, 2, 3." If a symbol is not included as a possibility from a given state, draw an arrow from the state to $NULL$ with that symbol on it.