Abstract

Fuzzy set theory has today emerged as a potential area of Research. In our thesis, we have tried to extend some of the concepts of finite automata to fuzzy automata. In particular, we have attempted to extend Myhill - Nerode theorem of finite automata to fuzzy automata under various compositions such as max-min composition, max-product composition and max-average composition.

In chapter 1, we have recalled the definition of fuzzy set and the various operations which can be carried out on fuzzy sets. We have illustrated the concepts with examples. In this chapter, we have proved a number of results (analogous to the results given in [7]) for max - product and max - average compositions. When a result does not hold good for max - product and / or max - average compositions, same has been illustrated by examples. DFA, NFA, NFA with ∈ moves, regular languages, their equivalences and fuzzy automata have been discussed in this chapter.

In Chapter 2, we have introduced the concept of fuzzy regular languages and have shown that if L is a fuzzy regular language (under max-min composition), then every $\alpha$ - cut $L_\alpha (\alpha \in [0, 1])$ is a regular language. We have shown this by proving that $L_\alpha = L (D_\alpha (M))$ where $D_\alpha (M)$ is a nondeterministic automaton associated with the fuzzy automaton M. We have also given a characterization of fuzzy regular languages and have illustrated the same with an example.

Chapter 3 deals with extension of Myhill-Nerode theorem for fuzzy automata where the composition considered is max-min composition. However, this extension does not help us in reducing the number of states in a fuzzy automaton for which we have provided an alternative method. We have illustrated the techniques with examples. An algorithm also has been developed for minimizing number of states in a fuzzy automaton. The algorithm has been tested using C language.

In Chapter 4, we have considered max-product composition. Unlike max-min composition, $L_\alpha$ need not be equal to $L (D_\alpha (M))$ in the case of max-product
composition. However, $L_\alpha$ is a subset of $L (D_\alpha (M))$. This has lead to further challenges and we could still prove the analog of Myhill-Nerode theorem for max-product composition.

Chapter 5 deals with max-average composition. With example, we have shown that in this case, $L_\alpha$ is not even a subset of $L (D_\alpha (M))$. Hence we had to go for splitting and still we could prove the analog of Myhill-Nerode theorem for max-average composition.

In Chapter 6, we have discussed the following applications of fuzzy automata.

First application is concerned with the comparison of two strings (how far they are closer). Fuzzy automaton is more useful than finite automaton in this task.

In the second application, a variation of A* algorithm is implemented to search a word in a dictionary of words. We construct fuzzy automaton to build the dictionary of words. An algorithm has been developed to search a given word in the dictionary. The algorithm gives best possible path. The algorithm has been tested using C language.

In the third application, an attempt has been made for adjusting a finite automaton to fuzzy automaton. It will guide us in determining the path which should be modified in case the word we are searching for is not found in the dictionary. An algorithm has been developed to find the best possible path for a given word. The algorithm has been tested using C++ language.