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N-Triangular Form of Fuzzy Context Free Grammar

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Abstract

In this paper a new triangular form of fuzzy context free grammar and N-triangular form of fuzzy context free grammar are defined with examples.

Keywords: Fuzzy context free grammar, Triangular form of fuzzy context free grammar, N-triangular form of fuzzy context free grammar.

1. Introduction

Lee and Zadeh [1] established Chomsky and Greibach Normal Form for the fuzzy context free grammars. In a fuzzy context-free grammar G the degree of membership of a production lies in [0, 1]. Consequently, strings derived from G fully belong to the language L(G), or they do not belong to L(G) at all, or their degree of membership with respect to L(G) strictly lies in between 0 and 1. In [2], [3] it was argued that fuzzy context-free grammars are suitable for modeling situations in which only finitely many grammatical errors occur. For the definitions of Fuzzy context free Grammars [4] and [5] may be referred.

In the existing approach given a language L over an alphabet $\sum$, a finite description of L is constructed by means of a fuzzy context free grammar G such that the fuzzy language L(G) generated by G satisfies L(G)=L. In this paper fuzzy context free grammar G is derived using N-triangular fuzzy number. Here discrete values in [0, 1] is constructed for the membership grade of the string. Using this concept it is easy to find fuzzy grammar for a given fuzzy language compared to the existing approaches like in [1]. Here the membership degrees of the productions are calculated using number of alphabets in the right hand side of the production.

2. Triangular form of Fuzzy Context Free Grammar

Fuzzy triangular form of context free grammar is a four-tuple (V_N, V_T, P, S) where

i) V_N is a non-empty set whose elements are called variables.

ii) V_T is a finite non empty set whose elements are called terminals.

iii) $V_N \cap V_T = \varphi$

iv) $S = A_i \in \{A_1, A_2, ...A_n\}$ is a special variable called start symbol.

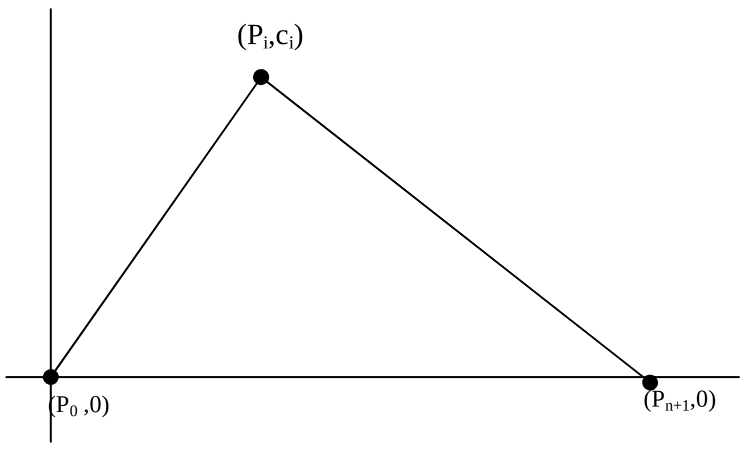
v) The set of productions P of the form

$$P_0 : S_1 \xrightarrow{0} \Lambda,\ \ P_1 : A_1 \xrightarrow{c_1} \alpha_1,\ P_2 : A_2 \xrightarrow{c_2} \alpha_2 \ldots P_i : A_i \xrightarrow{c_i} \alpha_i$$

$$P_{i+1} : A_{i+1} \xrightarrow{c_{i+1}} \alpha_{i+1}, P_n : A_n \xrightarrow{c_n} \alpha_n, P_{n+1} : S_2 \xrightarrow{0} \Lambda$$

Where Λ is empty string, $\alpha_1, \alpha_2, ..., \alpha_n \in (V_N \cup V_T)^*$ and $|\alpha_1| < |\alpha_2| < \ldots |\alpha_i| > |\alpha_{i+1}| > |\alpha_{i+2}| > \ldots |\alpha_n|$

The number of alphabets in α_j is denoted by $|\alpha_j|$. Here c_j's, $j \in \{1, 2, 3, ..., n-1\}$ is used to denote the membership grade of the production P_j. c_j, $j \in \{2, 3, ..., n-1\}$ is calculated using $c_j = \dfrac{|\alpha_j|}{|\alpha_i|}$, where α_i is a string with maximum number of alphabets. c_1 is fixed as $c_1 < c_2$ *and* $c_1 \in (0, c_2)$. Similarly c_n is fixed as $c_n < c_{n-1}$ *and* $c_n \in (0,1)$. The membership grades of P_j's are considered in the y-axis, the production P_j's are considered in the x-axis in such a way that the resulting structure is a triangle. Here the interval between P_j's need not be equal in the x-axis and the corresponding structure should have the following structure.



Example 2.1

Consider the following triangular form of fuzzy context free grammar.

G = (V_N, V_T, P, S), where $V_N = \{S, A, B, S_1, S_2\}$, $V_T = \{a, b\}$ and the Productions P are given by

$$P_0 : S_1 \xrightarrow{0} \Lambda, P_1 : A \xrightarrow{0.2} a, P_2 : S \xrightarrow{0.5} bA, P_3 : A \xrightarrow{0.75} bSA$$

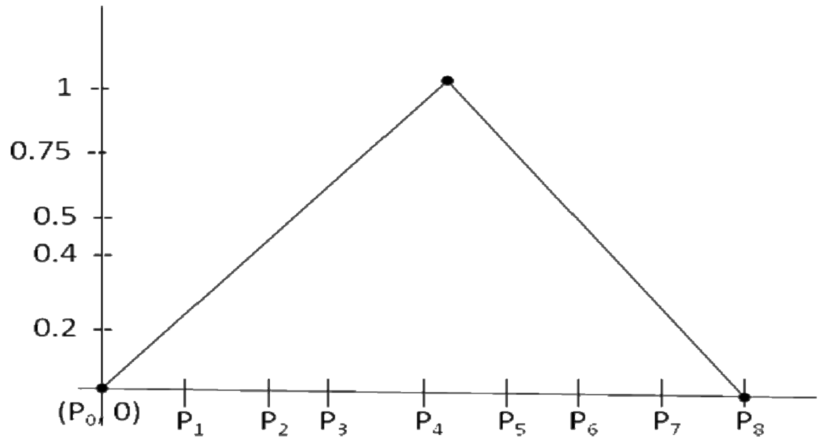
$$P_4 : B \xrightarrow{1} abAB, P_5 : B \xrightarrow{0.75} aSB, P_6 : S \xrightarrow{0.5} aB, P_7 : B \xrightarrow{0.4} b, P_8 : S_2 \xrightarrow{0} \Lambda$$

$$Here\, c_1 = 0.2,\ c_2 = 0.5,\ c_3 = 0.75, c_4 = 1, c_5 = 0.75, c_6 = 0.5, c_7 = 0.4$$

$$c_1 < c_2\ ; c_1 \in (0, c_2), Also\ \ c_7 < c_6\ \ \& c_7 \in (0,1)$$

The corresponding Language is L(G) = {(ab, 0.2), (b(a+b)*, 0.2), (a(a+b)*, 0.2) , (a(a+b)*,0.4)}

and the corresponding structure of the graph is given below.



3. N-Triangular form of Fuzzy context free grammar

The N-triangular form of fuzzy context free grammar is a four tuple $(V_N, V_{T,} P, S)$. Here $V_N, V_{T,}$ S are defined as in Triangular form of fuzzy context free grammar. The set of Productions are in the following form.

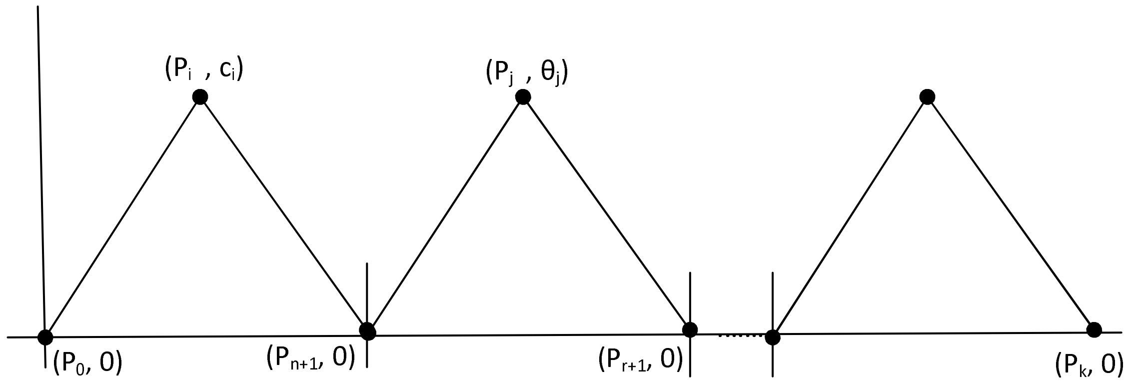
$$P_0 : S_1 \xrightarrow{0} \Lambda \quad P_1 : A_1 \xrightarrow{c_1} \alpha_1,\ P_2 : A_2 \xrightarrow{c_2} \alpha_2 \ldots P_i : A_i \xrightarrow{c_i} \alpha_i$$

$$P_{i+1} : A_{i+1} \xrightarrow{c_{i+1}} \alpha_{i+1}, P_n : A_n \xrightarrow{c_n} \alpha_n, P_{n+1} : S_2 \xrightarrow{0} \Lambda,$$

$$P_{n+2} : B_1 \xrightarrow{\theta_1} \beta_1,\ P_{n+3} : B_2 \xrightarrow{\theta_2} \beta_2, \ldots, P_j : B_j \xrightarrow{\theta_j} \beta_j,\ P_{j+1} : B_{j+1} \xrightarrow{\theta_{j+1}} \beta_{j+1}, \ldots, P_r : B_r \xrightarrow{\theta_r} \beta_r,$$

$$P_{r+1} : S_3 \xrightarrow{0} \Lambda, \ldots, P_k : S_{N+1} \xrightarrow{0} \Lambda$$

Here the productions P_0 to P_{n+1} forms a triangular form, where α_i has the maximum number of alphabets among $\alpha_1, \alpha_2, ..., \alpha_n$, also c_i’ s (i = 1,2,..n) are calculated by the same way as earlier. Similarly the productions P_{n+1} to P_r forms another triangular form, β_j has the maximum number of alphabets among $\beta_1, \beta_2, ..., \beta_r$, also θ_j’ s (j = 1,2,…,r) are calculated by the same way as earlier, continue like this we get N-triangular form of fuzzy context free grammar. The corresponding structure of the graph is given below.



Example 3.1
Consider the following 2-triangular form of fuzzy context free grammar.

G = (V_N, V_T, P, S) where $V_N = \{S, A, B, S_1, S_2, S_3\}, V_T = \{a, b\}$ and the Production P is given by

$$P_0 : S_1 \xrightarrow{0} \Lambda, P_1 : A \xrightarrow{0.2} a, P_2 : S \xrightarrow{0.5} aS, P_3 : S \xrightarrow{0.75} aaA, P_4 : S \xrightarrow{1} aabA, P_5 : A \xrightarrow{0.2} b, P_6 : S_2 \xrightarrow{0} \Lambda$$

$$P_7 : B \xrightarrow{0.3} a, P_8 : S \xrightarrow{0.5} bS, P_9 : S \xrightarrow{0.75} bbB, P_{10} : S \xrightarrow{1} bbaB, P_{11} : B \xrightarrow{0.5} bB, P_{12} : B \xrightarrow{0.3} b, P_{13} : S_3 \xrightarrow{0} \Lambda$$

The corresponding L(G) is

$$L(G) = \{(a^n, 0.2), (a^{n-1}b, 0.2), (a^{n-2}b^2, 0.2), (b^n, 0.3), (b^{n-1}a, 0.3), (b^{n-2}a^2, 0.3)\}$$

Conclusion

Triangular form of fuzzy context free grammar is useful to avoid the empty string in a fuzzy language. If all the string of the fuzzy language has unequal membership degree then it is very difficult to find the fuzzy context free grammar. To avoid this we can use N-triangular form of fuzzy context free grammar. Different types of languages can be obtained in a single fuzzy triangular form of fuzzy context free grammar. Using Triangular form of fuzzy context free grammar we can generate Language with out any ambiguity.

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