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Application of Fuzzy Algebra in Automata theory

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ABSTRACT: *In our first application we consider strings of fuzzy singletons as input to a fuzzy finite state machine. The notion of fuzzy automata was introduced in [58]. There has been considerable growth in the area [18]. In this section present a theory of free fuzzy monoids and apply the results to the area of fuzzy automata. In fuzzy automata, the set of strings of input symbols can be considered to be a free monoid. We introduced the motion of fuzzy strings of input symbols, where the fuzzy strings from free fuzzy submonoids of the free monoids of input strings. We show that fuzzy automata with fuzzy input are equivalent to fuzzy automata with crisp input. Hence the result of fuzzy automata theory can be immediately applied to those of fuzzy automata theory with fuzzy input. The result are taken from [7] and [34].*

Key Words: *Fuzzy strings, Pattern recognition, Membership function, Homomorphism semigroup, inferred fuzzy automata,*

I. INTRODUCTION

The basic idea is that the class of non-fuzzy system, that are approximately equivalent to a given type of system from the point of view of their behaviours is a fuzzy class of systems. For instances the class of system that are approximately linear .This idea of fuzzy classification of system was first hinted at by Zadeh 1965. Saridis 1975 applied it to the classification of nonlinear systems according to their nonlinearies, pattern recognition methods are first used to build crisp classes. Generally, this approach does not answer the question of complete identification of the nonlinearlies involved within one class. To distinguish between the nonlinearlies belonging to a single class, membership value in this class are defined for each nonlinearly one of thee considered as a references with a membership value 1.The membership value of each nonlinearity is calculated by comparing the coefficients of its polynomial series expansion to that of the reference nonlinearlity. This technique of classification is similar to those used in fuzzy pattern classification.We now mention some other way $\Rightarrow$ fuzzy abstract algebra has been applied. The paper [35] deals with the classification of knowledge when they are endowed with some fuzzy algebraic structure. By using the quotient group of symmetric knowledge as algebraic method is given in [35] to classify them also the anti fuzzy sub groups construction used to classify knowledge.

In the paper [20] fuzzy points are regarded as data and fuzzy objects are constructed from the set of given data on an arbitrary group. Using the method of least square, optimal fuzzy subgroups are defined for the set of data and it is shown that one of them is obtained as f fuzzy subgroup by a set of some modified data.In [55], a decomposition of an valued set given a family of characteristic functions which can be considered as a binary block code. Conditions are given under which an arbitrary block code corresponds to L-valued fuzzy set. An explicit description of the Hamming distance, as well as of any code distance is also given all in lattice-theoretic terms. A necessary and sufficient conditions is given for a linear code to correspond to an L-valued fuzzy set.

Lemma1: $\Phi_1 < \Phi_2 < \ldots..\Phi_n < 1$. As the asymmetric between code words on which fuzzy codes will be based become large, there is only a small increase in the measurable distance between codewords. For unidirectional errors, the case is that the space of the code will effect the distance between the fuzzy code words. These issues must be taken into account in designing fuzzy codes.

Lemma 2: $\Gamma_1 < \Gamma_2 < \ldots \ \Gamma_n > 2$.

Proof: If instead of using the Hamming distance between two fuzzy codes, we used the asymmetric distance, so that

$$D_a(\tilde{A}_u,\tilde{A}_u)=\left(\sum_{w\in F^n}\left(\tilde{A}_u(w)-\tilde{A}_u(w)\right)V\sum_{w\in F^n}\left(\tilde{A}_v(w)-\tilde{A}_u(w)\right)V\right)$$

Then the following theorem holds.

Corollary 1: A fuzzy column vectors $h^1 \in A^n$ is independent of a set of fuzzy column vectors $\left\{\tilde{h}_1,\ldots,\tilde{h}_n\right\}$.

If S (i) = φ for any i ∈ {1,………, m}.

Proof: We give the algorithm for checking if a non-null column x_k in the Sub semimodule F is linearly dependent on a set of fuzzy vectors at the end of this section. In a set of the column vectors $\tilde{g}_i$, i = 1, ...n, is given a complete set of independent fuzzy vectors $\tilde{f}_i$, i = 1, ...i, can be selected such that subsemimodule generated by $\{\tilde{f}_i,\ldots,\tilde{f}_m\}$ contains the $\tilde{g}_i$ s the procedure is shown in the form of the flow chart.

We now consider a positive sample set R^+ = 0.8ab, 0.8aa,bb, 0.3ab, 0.2bc, 0.99bbc. The finite submatrix of the fuzzy Hankel matrix H(r) is shown.

Using the algorithm DEPENDENCE the independent columns of the fuzzy Hankel matrix have been indicated as F_1, F_2, F_5, F_6, F_7.

The finite submatrix of the fuzzy Hankel matrix H $(r)^2$.

$$\mu(a)=\begin{array}{c} S_1\\ S_2\\ S_3\\ S_4\\ S_5\\ S_6\\ S_7\end{array}\overset{\begin{array}{ccccccc}S_1&S_2&S_3&S_4&S_5&S_6&S_7\end{array}}{\begin{bmatrix}0&0&0&0&0&0&0\\0&0&.03&0&1&0&.08\\0&0&0&0&0&0&0\\0&0&0&0&0&0&0\\0&0&0&0&0&.08&0\\0&0&0&0&0&0&0\\0&0&0&0&0&0&0\end{bmatrix}}$$

$$\mu(b)=\begin{array}{c} S_1\\ S_2\\ S_3\\ S_4\\ S_5\\ S_6\\ S_7\end{array}\overset{\begin{array}{ccccccc}S_1&S_2&S_3&S_4&S_5&S_6&S_7\end{array}}{\begin{bmatrix}0&0&0&0&0&0&0\\0&0&0&0&0&0&0\\0&0&0&1&0&0&0\\0&0&0&0&0&0&0\\0&0&1&0&0&0&0\\0&0&0&0&0&0&1\\1&0&0&0&0&0&0\end{bmatrix}}$$

$$\mu(c)=\begin{array}{c} S_1\\ S_2\\ S_3\\ S_4\\ S_5\\ S_6\\ S_7\end{array}\overset{\begin{array}{ccccccc}S_1&S_2&S_3&S_4&S_5&S_6&S_7\end{array}}{\begin{bmatrix}0&0&0&0&0&0&0\\0&0&0&0&0&0&0\\0&0&0&0&0&0&0\\1&0&0&0&0&0&0\\0&0&0&0&0&0&0\\0&0&0&0&0&0&0\\0&0&0&0&0&0&0\end{bmatrix}}$$

$\mu(c) =$

	λ	ab	a	abc	bc	c	abbc	bbc	aabb	abb	bb
λ	0	.8	0	.3	.2	0	.9	0	.8	0	0
a	0	0	.8	0	.3	0	0	.9	0	.8	0
ab	.8	0	0	0	.9	.3	0	0	0	0	0
abc	.3	0	0	0	0	0	0	0	0	0	0
bc	.2	0	0	0	0	0	0	0	0	0	0
abb	0	0	0	0	0	.9	0	0	0	0	0
abbc	.9	0	0	0	0	0	0	0	0	0	0
aa	0	0	0	0	0	0	0	0	0	0	0
aab	0	0	.8	0	0	0	0	0	0	0	0
aabb	.8	0	0	0	0	0	0	0	0	0	0
	F_1		F_7		F_3	F_4	F_2	F_5			F_6

The algorithm depends also identifies column if any column vector $\tilde{h}(j)$ is dependent on the set of generator H ∪ (m) = $H \cup (m) = \{\hat{f}_1, \ldots, \hat{f}_m\}$ of the Hankel matrix as constructed intable.It also identifies the coefficient S_i, using the procedure ARRANGE CS(i), N, CARD(i) and the procedure COMPARESO(k), SO(K – 1).

Once the independent set of the column vectors are extracted, the next steps is to find out mathematic's μ(x), $x \in V_T$. In order to determine the matrices μ(x), x ∈ v the expression x F has to be computed for x = a, b, c and i = 1, ...,7, the matrices μ(a), μ(b) and μ(c) given in table. The x_i's can be computed from the relationship α = $F_1(\lambda)$, ..., $F_m(\lambda)$), where the vector corresponds to the entries in the set of independent columns F_1, ..., F_m for the row in H(r) labelled by λ thus

α = (0 0 0.90 0.2 0 0 0)

The vector β = (10 0 0 0 0 0) because the column F_1 is an independent column. Once α, β and μ(a), μ(b) and μ(c) have been determined the fuzzy automation can be constructed by the method described. The fuzzy automation that accepts the strings is shown

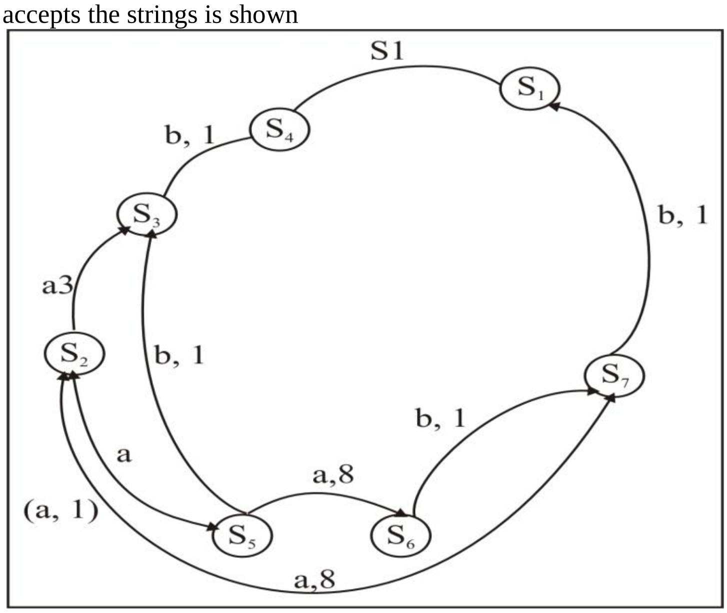


Fig 2: Inferred Fuzzy Automata

PROCEDURE DEPENDENFE

Step 1 i = 1 from S (i) such that

S (i) = $\{v_j \mid h_{ji} \geq h_i\}$

Find card (S (i))

Step 2: If card (S (i) = 0 go to step 12 Else do

Step 3: If card (S (i)) = 1 and S (i) = $\{j_k\}$.

$$\delta_{f_1} = \delta_{j_u} = h_i \text{ for } j = f_k,$$

for any other $j \neq j_k$, $\delta_{j_1} = 1$ go to step 5. Else do

Step4: If (S(i)) > 1

$$\delta_{j_1} = 0 \text{ and } \delta_{j_u} = h_i \text{ for all } j = j_k$$

for any other $j \neq j_k = \delta_{j_1} = 0,\ \delta_{j_u} = 1$

Step 5: i = i + 1 repeat the procedure until i = m.

Step 6: j = 1 find $v = \{\delta_{jkl}\}$ and $\{\delta_{jkl}\}$, k = 1, ...,n if $v = \{j_{jki}\} > \Lambda\{\delta_{jku}\}$ go to step 12. Else do

Step 7: Select a δ_j such that

$$\delta_{jkl} / Max < \delta_j < \delta_{jku} / min \text{ and set } R_j = \theta$$

Step 8: From $R_j = R_j$ V i (i ∊ 1, ... , n) such that
$h_i = \delta_j \Lambda h j i)$

Step 9: j = j + 1 if j < n, go to step 6

Step 10: Check if R_j converse all i ∊ {1, ...n} if R_j = {1, ...n} go to step 11.

Step 11: Else do go to step 12.

$\hat{h}$ is dependent, point the value of δ_{ji}.

Step 12: $\hat{h}$ is independent.

Theorem 1.1: Kleen – Schutzenberger for the free monoid $V_T^\star$.The set $A^{rec}[[V_T^\star]]$ and $A^{rat}[[V_T^\star]]$ conicide.
We now define the Hankel matrices. They can be used to characterize rational power series.

Definition: The Hankel matrix of r ∊ A $[[V_T^\star]]$ is a doubly infinite matrix H(r) whose rows and columns are indexed by the word $sV_T^\star$ and whose elements with the indices 4 are equal to (r, x_v)

A formal power series r∊A $[[V_T^\star]]$ is a function from, $V_T^\star$ to A, we denote the set of all function from $V_T^\star$ to A by $AV_T^\star$. The set $AV_T^\star$ also provides a convenient way to visualize the column of H(r) as element in $AV_T^\star$ we note that with the column H(r) corresponding to the word v ∊$V_T^\star$. We may associate the function f_u ∊ $AV_T^\star$ as follows

$\Rightarrow F_u(u) = (r, u\, v),\ \forall\, u \in V_T^\star$

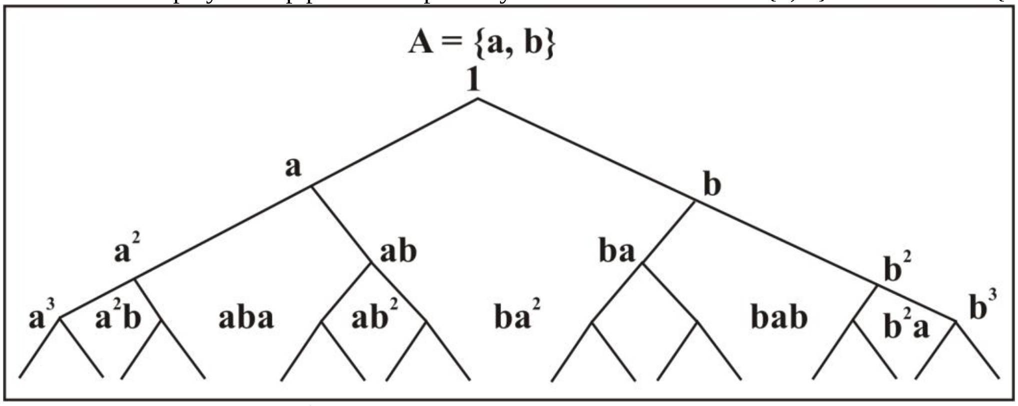
Definition 1.1: A code C over the alphabet A is called a prefix (suffix) code if it satisfies $CA^+ \cap C = \Theta$ $(A^+ C \cap C = \Theta)$. C is called a biprefix code of it is a prefix and a suffix code. A submonoid M of any monoid N. Satisfying of proposition.$CA^+ \cap C = \Theta$ is called the left unitary in N. M is called right unitary in N if it is satisfies the dual of $\forall\, x \in A^\star$, $Mw \cap M \neq \theta$ implies $w \in M$ namely $A^+ C \cap C = \Theta$.

Let M be a submonoid of a free monoid $A^\star$ and c its base then the following conditions are equivalent:

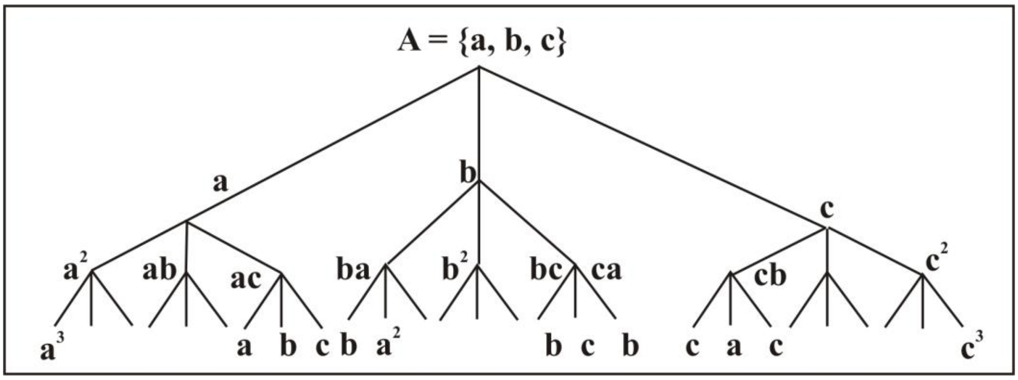
(i) $\forall\, w \in A^\star$, $Mw \cap M \neq \Theta$ implies $w \in M$

(ii) $CA^+ \cap C = \Theta$

By the condition (ii) in this proposition no word of C is a proper left factor of another word of C define the relation $\leq \ell$ on A^* by $\forall\, x, v \in A^*$, $x \leq \ell\, v$ if v is the left factor of u. Then ≤ 1 is a partial ordering of $A^\star$. In the diagram to follow we display the top part of $A^\star$ partially ordered $\leq \ell$ when A = {a, b} and when A = {a, b, c}



$A^\star$ partially ordered ≤ (when A = {a, b}

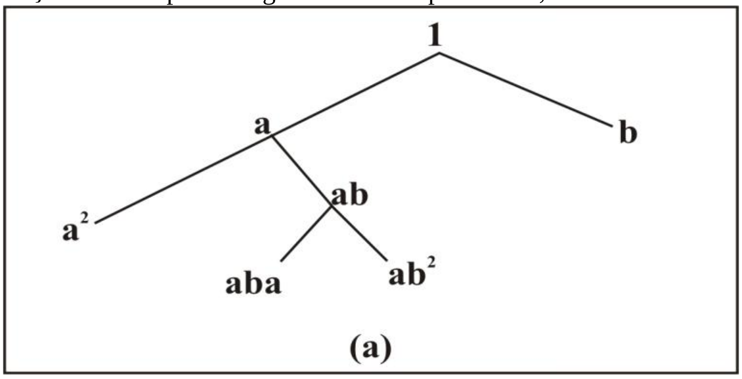


A★ partially ordered by ≤ ℓ

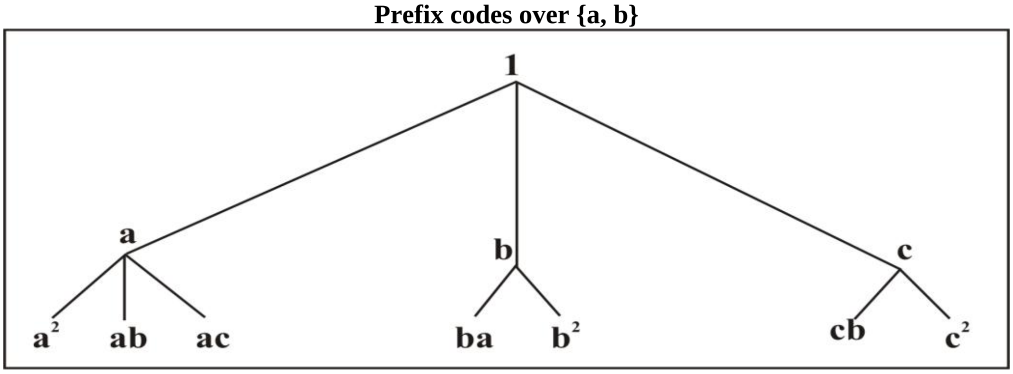
When A = {a, b, c}

A necessary and sufficient condition for a subset C i of A★ to be prefix code is that6 for every c ∈ C, w ∈ A★, w ≤ n ℓ, c and w ≠ c implies w ∉ C. This to obtain example of prefix codes, it suffices to select subsets C of A★ that will be end points for ≤ ℓ. For **Example:** The trees displayed below give the prefix codes. C_1 = {a^2,aba, ab^2, b} over {a, b} and c_2 = {a^2, ab, ac, ba, b^2, cb,c^2} over {a, b, c}. The set

〈 B = {a^n b | n∈ } is an example falling tree with end points a^nb, n ∈



Prefix codes over {a, b}



Prefix over code {a, b, c}

This is no simple characterization general codes analogous to condition. The proposition is to for prefix codes.

Proposition 1.1: Let A★ be a free monoid and C be a subset of A★. Define the subset D_i of A★ recursively by D_0 = C and D_i = {w ∈ A★ | D_{i-1}w ∩ c ≠ 0 or C w ∩ D_{i-1} ≠ Θ}, i = 1, 2, ... Then c is a code over A if and only if C ∩ D_i = Θ for i = 1, 2, ...

Suppose e is a finite then the length of the word in C. Hence there is only a finite number of distinct D_i and this proposition gives an algorithm for deciding whether or c is a code.

Proposition 1.2: Let S be a semigroup C a column system for S and ga homomorphism of B^+ into S. Then the function $\tilde{A} : B^+ \to C$ defined by ∀ x ∈ B^+ $\tilde{A}(x) = \langle g(x) \rangle b\ a\ c$ - sub-semigroup of B^+. If ∀ x, y ∈ B^+ if ∀ xy ∈ B^+

(i) x ∈ 〈y x, xy, y〉

(ii) x ∈ 〈y x, xy〉

(iii) x ∈ 〈x^n〉 ∀ n ∈

(iv) $x \in \langle y\, x, y\rangle$

(v) $x \in \langle xy, y\rangle$

(vi) $x \in y\, x, y > \cap \langle xy, y\rangle$

then $\tilde{A}$ is free, pure, every pure, left unitary, right unitary, or unitary, respectively. Moreover, $\tilde{A}X = g^{-1}(X)$ for every $X \in C$.

Example 1.1:

(i) For e = {c = a, a^3b, aba }
We have $D_0 = C$, $D_1 = \{a^2b, ba\}$
$D_2 = \{ab\}$ and $D_3 = \{a, b\}$
Since $C\ AD_3 \neq \Theta$, C is not a code

(ii) $C = \{a, a^2b, bab, b^2\}$ we have $D_0 = C$,
$D_1 = \{ab\}$, $D_2 = \{b\}$ and $D_i = \{ab, b\}$
For i = 3, 4 , ... Since $C \cap D_i = \theta$
For i = 1, 2 , ... C is a code.

Therefore we now consider the construction of codes using fuzzy subsemigroups. Let L is the partially ordered set L is called a Λ - semi lattice if ∀ x, y ∈ L x: x and y have a greatest lower bound least upper bound, say $x \cap y$ ($x \vee y$. AΛ - semilattice is called complete if for every subset of L has a greatest lower bound in L. Let $\left\{\tilde{A} \mid \tilde{A} : B^{+} \rightarrow L\right\}$ is a semi lattice whose elements are L-subsets of the free semigroup B^+. An L-subset $\tilde{A}$ of B^+ is an L-subsemigroup of B^+ if for it t ∈ L, the level set

$\tilde{A}^{+} = \left\{x \in B^{+} \mid \tilde{A}(x) \geq t\right\}$ is a subsemigroup of B^+. Then $\tilde{A}$ is a L-sub-semigroup of B^+ if ∀ x, y ∈ B^+

$$\tilde{A}(xy) \geq \tilde{A}(x) \cap \tilde{A}(y)$$

The search for suitable codes for communication theory is known. It was proposed by Garla-that-L-semi-group theory be used. To this end free, pure, very pure, left unitary, right unitary, unitary such L-submsemigroup there is a family of codes associated with it. An L-subsemigroup of a free semigroup if free, one are, pure, very pure, left unitary right unitary respectively.Thus any method used to construct an L-=subsemigroup of a free semigroup of one of these types yields a family of semigroups of the same types. Namely the level sets of the L - subsemigroup.

V. CONCLUSION

We have assumed that error in the transmitted of words across a noisy channel were symmetric in nature i.e., the probability of 1 ⇒ 0 and 0 ⇒ 1 cross over failures were equally likely. However error in VSLI circuit and many computer memories are on a undirectional nature [8] A undirectional error model assumes that both 1 ⇒ 0 ⇒ 1cross overs can occur, but only are type of error occurs in a particular data word. This has provided the basis for a new direction in coding theory and fault tolerance computing. Also the failure of the memory cells of some of the LSI transistor cell memories and NMOS memories are most likely caused by leakage of charge. If we represent the presence of charge in a cell by 1 and the absence of charge by 0, then the errors in those type of memories can be modeled as 1 ⇒ 0 type symmetric errors, [8].The result in the remainder of this section are from [15]. Once again F denotes the field of integers module 2 and F^n the vector space of n - tuples over F, we let p denotes the transmitted 1 will be received as a1 and a transmitted 0 will be received as a 0, Let q = 1–p. Then q is the probability that there is an error in transmission in an arbitrary bit.

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