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Fuzzy Rough Set Theory for Decision Support Systems

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Abstract: ***Decision Making is an art of obtaining optimal (sometimes satisfactory) solution of a problem. This procedure may not be always conventional or logical and sometimes it may involve irrational approaches, tacit knowledge, beliefs and faith. In this paper, we deal with the decision-making process when the datum is missing in the information system which possesses fuzzy decision attribute using the concept of rough sets.***

Keywords: Decision Making, rough sets, incomplete information systems, fuzziness

1. Introduction

For about a few decades, enormous work has been carried out in implementing fuzzy concepts in decision making because, due to complexity and constraints, we may not be able to arrive any crisp or clear decision through the available decision rules. In this regard, it is noteworthy to mention that Ganesan et.al. [1,2] proposed a mathematical frame work to deal with implementing the concept of rough approximations in the information systems with fuzzy decision attributes.

Whereas, in case of incomplete information systems [3,4,6], retrieval of the unknown value(s) is of complex in nature, as the missing value may be anything other than our predictions. Here, some of the common methods [5] which are in practise to fix the unknown values of the decision tables such as (a) Most Common Attribute Value Method (b) Maximum relative frequency method, or maximum conditional probability method (c) C4.5 Method (d) Event-Covering Method etc. In case of Incomplete Systems, there are several mathematical and statistical approaches as mentioned above are in practise to fix the unknown values of the records. However, all those methods do not deal with when, the decisions may be of fuzzy in nature.

2. Proposed Model

Considering this in view, Two methods are proposed here namely Fuzzy Similarity and Fuzzy Dissimilarity Approaches.

Here, we confine only with the information systems which possess only one unknown or missing value. For convenience, we name the records in which all the values are known as Complete Records and the records in which only one value is unknown or missing as incomplete records.

In All the methods, we propose the following Mathematical approach. For instance, the table is as follows:

	d_1	d_2	...	d_{j-1}	d_j	d_{j+1}	....	d_n
W_1	$X_{1,1}$	$X_{1,2}$	...	$X_{1,j-1}$	$X_{1,j}$	$X_{1,j+1}$	...	$X_{1,n}$
W_2	$X_{2,1}$	$X_{2,2}$	...	$X_{2,j-1}$	$X_{2,j}$	$X_{2,j+1}$	...	$X_{2,n}$
.	...	...	...	...	...	...	...	...
.	...	...	...	...	...	...	...	...
W_{i-1}	$X_{i-1,1}$	$X_{i-1,2}$	...	$X_{i-1,j-1}$	$X_{i-1,j}$	$X_{i-1,j+1}$	...	$X_{i-1,n}$
W_i	$X_{i,1}$	$X_{i,2}$	...	$X_{i,j-1}$	*	$X_{i,j+1}$	...	$X_{i,n}$
W_{i+1}	$X_{i+1,1}$	$X_{i+1,2}$	...	$X_{i+1,j-1}$	$X_{i+1,j}$	$X_{i+1,j+1}$	...	$X_{i+1,n}$
.	...	...	...	...	...	...	...	...
.	...	...	...	...	...	...	...	...
W_m	$X_{m,1}$	$X_{m,2}$	...	$m_{1,j-1}$	$X_{m,j}$	$X_{m,j+1}$	...	$X_{m,n}$

In the above table, $x_{i,j}$ is unknown and for which the value needs to be fixed or approximated in order to proceed the indexing algorithms which were discussed in the earlier chapters.

For any complete record w_t and the incomplete record w_i, the ***relative deviation*** (w_t, w_i) is given by

$$(w_t, w_i) = \frac{\sqrt{\left(x_{t,1} - x_{i,,1}\right) + \left(x_{t,2} - x_{i,,2}\right) + ... + \left(x_{t,j-1} - x_{i,,j-1}\right) + \left(x_{t,j+1} - x_{i,,j+1}\right) + \left(x_{t,j+2} - x_{i,,j+2}\right) + ... + \left(x_{t,n} - x_{i,,n}\right)}}{n-1}$$

The ***relative minimum quotient*** $\left\lfloor \frac{w_t}{w_i} \right\rfloor$ is given by

$$\left\lfloor \frac{w_t}{w_i} \right\rfloor = \min\left(\frac{x_{t,1}}{x_{i,1}}, \frac{x_{t,2}}{x_{i,2}}, ..., \frac{x_{t,j-1}}{x_{i,j-1}}, .\frac{x_{t,j+1}}{x_{i,j+1}}, ..., \frac{x_{t,n}}{x_{i,n}} \right)$$

The ***relative maximum quotient*** $\left\lceil \frac{w_t}{w_i} \right\rceil$ is given by

$$\left\lceil \frac{w_t}{w_i} \right\rceil = \max\left(\frac{x_{t,1}}{x_{i,1}}, \frac{x_{t,2}}{x_{i,2}}, ..., \frac{x_{t,j-1}}{x_{i,j-1}}, .\frac{x_{t,j+1}}{x_{i,j+1}}, ..., \frac{x_{t,n}}{x_{i,n}} \right)$$

For Example, consider a 4 tuple complete record A(4,6,5,3) and a 4 tuple incomplete record B(7,*,3,8).

The relative deviation (A,B) is given by

$$(A, B) = \frac{\sqrt{(4-7)^2 + (5-3)^2 + (3-8)^2}}{3} = 2.0548$$