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PROGRESSIVE DECISION MAKING IN THE DEPARTMENT OF CARDIOLOGY BY OPTIMIZED ROUGH SET MODEL

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ABSTRACT

Decision making is becoming a versatile field of research in healthcare environment. Physicians have to recommend the type of treatment before making decision whether the patient has the particular disease or not. Patients life expectancy also increases with the right decision and treatment recommended by the physicians. To reduce the diagnosis time and enhance the diagnosis accuracy, it has become more of a challenging issue to develop reliable and powerful medical decision support systems. All of these decisions will guide the physicians and improve the health of the patients. In this paper, Rough set theory is applied to reduce the uncertainty attributes and redundancy objects of heart data and to find the core attributes for decision making in the department of cardiology.

KEYWORDS: **Core, Coronary disease, Roughest, Reduct.**

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INTRODUCTION

Coronary disorder is likely one of the predominant sources of deaths all over the place throughout the arena. Coronary illness[1] is the main source of death and more than 40 of yearly passing. A normal of 1 death happens every 33 seconds. In addition to mortality, poorly managed coronary disease can lead to significant long-term disability from the complications of heart attacks, strokes, heart failure and end-stage renal disease. For instance, the clinic symptoms, the functional and the pathologic appearances of heart diseases are associated with numerous human organs other than the heart, and all the time heart diseases[2] may show different syndromes. In the meantime, different types of heart infections may have similar symptoms. To reduce the diagnosis time and enhance the diagnosis accuracy, it has become more of a challenging issue to develop reliable and powerful medical decision support systems to support the yet and still progressively complicated diagnosis decision process[3]. Among various life- threatening diseases, heart diseases have a great deal of attention in medical research. Also, it has more impact on human health. The most obvious reason for death in industrialized nations was because of cardiovascular infection. Hazard components for these pathologies incorporate diabetes, smoking, family history, corpulence, elevated cholesterol and so forth. Wellbeing data choice was empowered by especially thinking about the life structures and working of the heart[4]. Another conceived baby likewise has the likelihood of coronary illness. A percentage of the manifestations of coronary illness in individuals were mid-section torment and exhaustion. It happened while the heart does not meet the circulatory requests of the body. The doctor takes choice in light of the patient's responses to inquiries and lab results. Blood stream to the heart[5] muscles was diminished when square happens in coronary corridors. The electrocardiogram recordings were dissected to recognize anomaly of heart beat issues happened because of cardiovascular infections. Ahead of time of medicinal and surgical treatment the patient with coronary illness achieved adulthood. There are numerous ailments that influence the heart and corridors however four are especially pervasive. Myocardial localized necrosis was connected to harm to the coronary corridors in 90% of cases[6]. Strokes happened as an aftereffect of hindered blood stream to the cerebrum connected to a discharge or a blockage of the courses that supply blood to the mind. Heart attack was principally connected to different changes in cardiovascular tissues, frequently the consequence of ageing. Hypertension was characterized as the supported rise of blood vessel circulatory strain in contrast with what is thought to be the "ordinary" estimation of 140/90 millimeters of mercury. For this part, artificial intelligence techniques were utilized as a part of medical diagnosis change in forecast of coronary illness[7]. Rough set reasoning is one of the suitable methods for analysis and gives medicinal learning for diagnosis purposes. Rough Set methodology is concerned with the classification and analysis of imprecise, uncertain or incomplete information and knowledge, and has been considered as one of the first non-statistical approaches in data analysis. The extent of rough set applications used today is much wider than in the past, principally in the areas of medicine, analysis of database attributes and process control[8]. RST has some overlaps with other methods of data analysis, e.g., statistics, cluster analysis, fuzzy sets, evidence theory and others but it can be viewed in its own rights as an independent discipline. The rough set approach seems to be of fundamental importance to AI and cognitive sciences, especially in the areas of machine learning, knowledge acquisition and decision analysis, knowledge discovery from databases, expert systems, inductive reasoning and pattern recognition[9]. It seems of particular importance to decision support systems. This theory has been successfully applied in many real-life problems in medicine, pharmacology, engineering, banking, financial and market analysis and others[10]. In this paper, the primary decision of coronary disease is done using Rough set theory (RST). The RST will help us in three ways. First, it will propose indiscernibility in the dataset. Secondly, it gives lower and upper approximations to decide the boundary region to find out whether the set is crisp or rough set. In the third step, reducts and core will be finding and finally rules are generated by removing redundancies in data.

Literature survey on heart disease

To gain the background knowledge the survey includes that Carlos Ordonez[1] introduced an algorithm to minimize the quantity of rules which used search Limitation. The introduced algorithm investigates for association principles in a training set and ultimately validates them on an independent test set. They provided medically tremendous rules discovered on clinical data a set that remain valid in several independent train/test cycles. K.C. Tan and E.J. Teoh *et al*[2] *1* have introduced a hybrid procedure involve two traditional machine learning algorithms. Genetic Algorithms (GAs) and Support Vector Machines (SVMs) have been the two proposed algorithms consolidated easily in view of a wrapper method. Here, by an evolutionary framework genetic algorithm factor searches for the first-class attribute data set. In light of the quality subset represented by GA, the SVM arranged the examples into diminished information set. Jesmin Nahar and Tasadduq Imam *et al*[3]have developed an intelligent based approach for the diagnosis of heart diseases. Apriori, Predictive Apriori and Tertius have been the three different rule mining algorithms used to present rule extraction experiment on heart disease data and confirmed as efficiency algorithm for analysis task. Cleveland dataset, a publicly available dataset and commonly well-known with data mining researchers, were used for diagnosis. Kemal Polat and Salih Gunes[4] have developed a feature selection approach known as Kernel F-score Feature Selection (KFFS) which is used as pre-processing phase in the classification of clinical datasets. The proposed KFFS method consists of two phases. In first phase by means of Linear (Lin) or Radial Basis Function (RBF) kernel functions, the features of medical datasets have been converted to kernel space. Using F-score formula, the F-score values of clinical datasets with high dimensional feature space have been estimated. To experiment the

performance of KFFS method the UCI (University California, Irvine) machine learning database used coronary heart disease dataset, SPECT (Single Photon Emission Computed Tomography) images dataset and Escherichia coli Promoter Gene Sequence dataset. Pasi Luukka and Jouni Lampinen[5] have implemented classification technique based on preprocessing the data first with Principal Component Analysis (PCA) and then making use of differential evolution classifier to the prognosis of coronary heart disease. This procedure was utilized right here for predicting prognosis from medical data sets. The result indicated that preprocessing the data before classification might not only support with the curse of increasing data dimensionality, but also provide a further enhancement in classification accuracy. Resul Das and Ibrahim Turkoglu, *et al*[6] have recommended different tools and various methodologies to create effective medical decision supportive network. A framework was presented which makes utilization of Statically Analysis System (SAS) base programming 9.1.3 for diagnosing of the coronary illness. Hongmei Yan and Jun Zheng, *et al* [7]have presented a genuine coded GA based framework to choose the basic medicinal components key to the coronary heart illnesses determination. It has been proposed to choose the basic elements and help the finding of five principle heart infections which were hypertension, coronary illness, rheumatic valvular coronary illness, perpetual pulmonale and innate coronary illness. Akin Ozcift and Arif Gulten[8]have developed a Rotation Forest (RF) ensemble classifier. Here rotation forest (RF) ensemble classifiers of 30 machine learning algorithms to evaluate their classification performances utilizing Parkinson's, diabetes and coronary heart diseases data sets. Using correlation based feature selection algorithm 3 data sets have been minimized and then performances of 30 machine learning algorithms were estimated for 3 data sets and constructed based on RF algorithm. Chih-Lin Chi and W. Nick Street, *et al*[9] have proposed Optimal Decision Path Finder (ODPF) which was machine learning based expert system. It was utilized due to instructive as a part of terms of indicative precision in the event of minimizing the time and cost spent on diagnostic testing. Vidyullatha pellakuri, D.Rajeswara Rao[10] proposed roughest method using rough set exploration system RSES2.2 software for decision making on early stage of chronic kidney sickness. This gain knowledge of tested that the speculation of rough sets by all accounts a useful decision making for knowledge learning and large support for constructing expert systems. Yoon-Joo Park and Se-Hak Chun, et al, [11] have proposed Cost-Sensitive Case-Based Reasoning(CSCBR), another learning extraction system. It included unequal misclassification cost into customary case based thinking. To order the nonappearance and vicinity of ailment hereditary calculation was utilized. An exertion was taken to minimize misclassification blunder costs into CBR by the best grouping of limit point and number of neighbor. Jesmin Nahar and Tasadduq Imam, et al[12] have examined the fact of computational smart techniques in coronary disease finding. Cleveland data was used to perform connection with six comprehended classifiers. For most classifiers and larger part data set the execution was improved by the use of Motivated Feature Selection (MFS). Laercio Brito Gonçalves and Marley Maria Bernardes Rebuzzi Vellasco*, et al*[13] have determined that the Inverted Hierarchical Neuro-Fuzzy Binary Space Partitioning (HNFB-1) was based on the Hierarchical Neuro-Fuzzy Binary Space Partitioning Model (HNFB) which gave an idea that recursive partitioning of the input space. It was able to generate its own structure automatically and allowed a greater number of inputs. The classification task of HNFB-1 has been evaluated with different benchmark databases such as heart disease datasets. It allowed the extraction of knowledge in the form of interpretable fuzzy rules. Vidyullatha pellakuri, D.Rajeswara Rao [14]proved that fuzzy logic inference innovation is not hard to apply for generating rules very surprising and satisfying end to create projects with less expensive arrangements. Kemal Polat and Salih Gunes [15] have presented a hybrid approach based on feature selection, fuzzy weighted preprocessing and Artificial Immune Recognition System (AIRS) to medical decision support systems. The hybrid approaches based on feature selection have two stages. The dimensions of heart disease and hepatitis disease datasets were reduced to 9 from 13 and 19 in the feature selection (FS) sub-program by means of C4. 5 decision tree algorithm. AIRS have showed an effective performance on several problems such as machine learning benchmark problems and medical classification problems like breast cancer, diabetes and liver disorders classification. They have used the heart disease and hepatitis disease datasets taken from UCI machine learning database as medical dataset. Vidyullatha pellakuri, D.Rajeswara Rao[16] developed a predictive modeling using multivariate regression analysis & artificial neural network where consists of statistical parameters such as R, R-square, Adjusted R-square, MAE, RMSE on real statistical data set acquires 99% accuracy. Nazri Mohd Nawi and Rozaida Ghazali et al[17] have proposed a novel strategy to enhance the effectiveness of back propagation neural network. In Gradient Descent with Momentum and Adaptive Gain proposed calculation, for every hub the addition quality was changed adaptively to alter initial search. The coronary illness of the patient was anticipated productively and the calculations were firmly built and can upgrade the computational productivity. Lakshmi Prasanna[18]discussed the semantic web is the best method for the data representation building ontologies and resource description framework for Chinese biomedical databases to gain the knowledge.

METHODOLOGY

In this paper, we characterize a coronary disease dataset utilizing roughest theory [10] which is an early application of knowledge discovery systems, and it can be used to increase the likelihood of correct predictions by identifying and removing redundant variables. The principle idea of rough set hypothesis is an indiscernibility relation connected with set of attributes. Cases with the same variables are assembled as rudimentary sets. Cases inside of each basic set are indiscernible. Conflicting information sets are taken care of by rough set hypothesis utilizing lower and

upper approximations for each idea. These approximations are perceptible utilizing existing variables. Besides, from the idea lower and upper approximations certain and conceivable guideline sets are prompted utilizing one procedure of information mining called rule induction. By and large, enter information sets are every now and again deficient, i.e., some variable values are absent. The primary step is preprocessing of information and afterward fundamental handling of information mining, for example, rule induction. Ordinarily, preprocessing manages with replace the missing variable values by the most widely recognized worth, overlooking cases with missing variable values, and so on[11]. The first reason is that an attribute value, for a specific case, is lost. This may happen when the original value was erased or mistakenly not included into the data set. The second one is learning is gained specifically from inadequate information sets considering that some variable values are absent. Moreover, it is accepted that there are two purposes behind information to be incomplete. The second explanation behind fragmentation depends on the absence of significance. It is assumed that in the same decision table some attribute values are lost and some are "do not care" conditions from the view point of rough set theory where a method for rule induction was introduced in which each missing attribute value was replaced by all values from the domain of the attribute[12]. Originally such values were replaced by all values from the entire domain of the attribute, selected results of tests (attributes), while other test results were redundant. Any limited union of basic sets is a perceptible set. On the off chance that an arrangement of attributes does not contain any repetitive data, it is a negligible set or a reduct. When reducts are built up, decision rules are created connecting the variables to the result on an advancement test. These decision rules[13] are then connected to new information and the characterization rate is resolved and the relative significance of variables to results can be perceived. Rough Set Theory manages data spoke to by a table called a data framework, which comprises of objects and attributes. For illustration, let us consider the coronary data framework which contains five conditional attributes and one decision attribute having membership functions such as {High, Low, Very High, Normal, Yes and NO}which was shown in Table 1. According to the rough sets theory, an information system can be considered as a decision table, which is used to specify what conditions lead to decisions. From the Table1, there are five conditional attributes (C) and one decision attribute (D) to make decision on heart failure 'yes' or 'no' by using rough set theory.

Table1
Attribute information system for Heart Data

S.NO	Attributes	Description
1	Heart palpitation(HP)	Palpitation (heart beat) is one of the sign for heart attack. Generally the heart beats 60 to 100 times/minute. When the heart beats below 60 or above 100 intimates low, high or very high.
2	Blood pressure (BP)	Blood pressure is of two types. Low blood pressure and high blood pressure
3	Fatigue	Fatigue is the aging factor of a heart. The membership functions are low fatigue and high fatigue.
4	cholesterol	For coronary illness, the high cholesterol is also one of the risk factors leading to heart disease. The factors are
5	Shortness of Breath	Breathlessness or difficulty for breathing causes high levels of activity like exhaustive exertion
6	Decision	Decision on Heart illness is yes or no

Table 2
Attribute value information for Heart Data

S.NO	Attributes	Label	Count
1	Heart Palpitation (HP)	H: High rate of heart beat	5
		VH: Very high rate of heart beat	2
		L: Low level heart beat	3
2	Blood Pressure (BP)	H: High level of blood pressure	7
		L: low level of blood pressure	3
		VH: Very high blood pressure	0
3	Fatigue	L: low level of fatigue	9
		N: Normal level of fatigue	1
4	Cholesterol	N: Normal level of cholesterol	2
		L: low level of cholesterol	7
		H: High level of cholesterol	1
5	Shortness of Breath (SOB)	L: Less Breath	6
		N: Normal Breath	4
6	Decision (D)	Y: Heart disease -Yes	6
		N: Heart Disease - No	4

RESULTS AND DISCUSIONS

From the given data, there are five conditional attributes (C) and one decision attribute (D) to make decision on heart failure 'yes' or 'no' by using rough set theory. Let the conditional attributes

Table 3
Attribute value information for Heart Data

Patient	HP a1	BP a2	Fatigue a3	Cholesterol a4	SOB a5	Decision D
1	H	H	L	N	L	Y
2	L	L	L	N	N	N
3	L	H	N	L	L	N
4	VH	L	L	L	N	Y
5	H	H	L	L	L	Y
6	L	H	L	H	N	N
7	H	H	L	L	L	Y
8	H	H	L	L	L	Y
9	H	H	L	L	L	N
10	VH	L	L	L	N	Y

C = {a1, a2, a3, a4, a5}
D = {(1, 4, 5, 7, 8, 10), (2, 3, 6, 9)}
Indiscernibility of conditional attributes (C):
IND(C) = {1, 2, 3, (4, 10), (5, 7, 8, 9), 6}.
Let C1= {a1, a2, a3, a4};
C2 = {a1, a2, a3, a5};
C3 = {a1, a2, a4, a5);
C4 = {a2, a3, a4, a5}
IND(C1)={1,2,3(4,10),(5,7,8,9),6}
IND(C2)={(1,5,7,8,9),(2,3),(4,10),6}
IND(C3)={1,2,3(4,10),(5,7,8,9),6};
IND(C4)= {1,2,3,(4,10),(5,7,8,9),6}.
Lower approximation of C:
C_L= {1, 2, 3, 6}
Similarly, C_{1L} = {1,2,3,6}
C_{2L}={2,3,6} C_{3L}={1,2,3,6} C_{4L}={1,2,3,6}.

The positive regions of C_{1L}, C_{3L}, and C_{4L} are same as C but not C_{2L}. Hence, C_{1L}, C_{3L}, and C_{4L} are called set of reducts of C and core = {a2, a4}. C_L ={1,2,3,6}; C_U={1,2,3,6,4,10,5,7,8,9,6}. Boundary region of X=BN(X)={C_U-C_L}={4,5,7,8,9,10}≠ϕ. As the BN(X) is not a null set then this set is called rough set. The Reduct = {C1, C3, C4}; core={a2, a4}. Since the core attributes a2 and a4 cannot be deleted from table, the strengths (α) of a1, a3 and a5 are to be calculated are shown in the table.

If a1=VH, D=Y, then α=|a1UD| / |a1|=2/2=100%
If a1=H, D=Y, then α =|a1UD| / |a1|=4/5=80%
If a1=VH, D=N, then α =|a1UD| / |a1|=1/4=25%
If a1=L, D=N, then α =|a1UD| / |a1|=3/3=100%
If a3=L, D=Y, then α =|a3UD| / |a3|=6/9=66%
If a3=N, D=N, then α =|a3UD| / |a3|=1/1=100%
If a5=L, D=Y, then α =|a5UD| / |a5|=4/6=66%
If a5=N, D=N, then α =|a5UD| / |a5|=2/4=50%.

The following table3 clearly indicates the strengths of a1, a3 and a5. From the Table 3, a1 is stronger than a3 and a5. Therefore conditional attributes a1, a2 and a4 are required to be considered for further reduction. It is observed that rows 4 & 10 are alike and rows 5, 7 & 8 are same. After removing duplicate rows, we will get reduced table4. This is called Row Reduction. Further reduction is carried out based on decision attribute D considering conditional attributes one by one. Let us consider a1 and D, a2 and D, a4 and D. The resultant tables are shown below. From the sets the intersection:

{(1,2,4,7) Λ (1,2,3,4) Λ (1,2,3,4,6)} = (1,2,4).

Now consider pair of attributes along with decision attributes D: based on (a1, a2, D)
(a1, a4, D) and (a2, a4, D) which shown in tables. The Intersection of {1,2,3,4,7}Λ{1,2,3,4,5,7}Λ{1,2,3,4,5,6}= {1,2,3,4}. Again intersecting table 6 and table 10 the final table 11 is shown.

Table4
Strength Table for Conditional Attributes

Strengths α	a1		a3		a5	
	Decision Yes	Decision No	Decision Yes	Decision No	Decision Yes	Decision No
α_{VH}	100%	-	-	-	-	-
α_{H}	80%	25%	-	-	-	-
α_{L}	-	100%	66%		66%	
α_{N}	-	-	-	100%	-	50%
TOT	305%		166%		116%	

Table5
Row Reduction Method On Heart Dataset

Patient	a1	a2	a4	D
1	H	H	N	Y
2	L	L	N	N
3	L	H	L	N
4	VH	L	L	Y
5	H	H	L	Y
6	L	H	H	N
9	H	H	L	N

Table 6
Indiscernbility Table Considering Every Conditional Attributes

Attributes	Labels	Decision	Objects
a1	H	Y	1
	VH	Y	4
	L	N	2
	H	N	7
a2	H	Y	1
	L	Y	4
	L	N	2
	H	N	3
a4	N	Y	1
	L	Y	4
	N	N	2
	L	N	3
	H	N	6

Table 7
Intersection Method from Table 6 on Heart Dataset

P	a1	a2	a4	D
1	H	H	N	Y
2	L	L	N	N
4	VH	L	L	Y

Table 8
From the Reduction Table 5, the Attributes a1, a2 and D are shown

P	a1	a2	D
1	H	H	Y
2	L	L	N
3	L	H	N
4	VH	L	Y
7	H	H	N

Table 9
From the Reduction Table 5, the Attributes a1, a4 and D are shown

P	a1	a4	D
1	H	N	Y
2	L	N	N
3	L	L	N
4	VH	L	Y
5	H	L	Y
7	H	L	N

Table 10
From the Reduction Table 5, the Attributes a2, a4, D are shown

P	a2	a4	D
1	H	N	Y
2	L	N	N
3	H	L	N
4	L	L	Y
5	H	L	Y
6	H	H	N

Table 11
Intersection Method for Tables 8, 9 and 10.

P	a1	a2	a4	D
1	H	H	N	Y
2	L	L	N	N
3	H	H	L	N
4	VH	L	L	Y

Table12
Intersection Method on Table 7, 11

P1	a1	a2	a4	D
1	H	H	N	Y
2	L	L	N	N
4	VH	L	L	Y

4.1 Rule Generation

If heart palpitation is high and blood pressure is high and cholesterol is normal then the patient may have heart problem. If heart palpitation is low and blood pressure is low and cholesterol is normal then the patient may not have heart problem. If heart palpitation is very-high and blood pressure is low and choleatral is low then the patient may have heart problem. The rules are in the following manner where a1= heart palpitation, a2= blood pressure and a4= cholesterol.

1. IF a1=H and a2=H and a4=N, THEN D=Y
2. IF a1=L and a2=L and a4=N, THE D=N
3. If a1=VH and a2=L and a4=L, THEN D=Y

CONCLUSION

Over the years RST has become a valuable mathematical approach in the resolution of various problems, such as representation of uncertain or imprecise knowledge particularly in the medical field. From the above rules, the cardiologist can make the decision whether the out-patient is probably having heart problem or not by just looking into three parameters such as heart palpitation, blood pressure and cholesterol. Thus, RST has given simple solution by reducing from so many objects and attributes into three and generated just three rules to diagnose the major problems like heart attack. If number of parameters is too large, then software tools are used to determine reducts and core. The rules generated using rough set approach will provide a good clarity and more accuracy over the incomplete data set. The future research is going on to implement the Roughest with soft computing techniques on large databases. 0

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