Rough Topology Based Decision Making in Medical Diagnosis

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***Abstract*— This paper gives an algorithm in terms of Rough Topology to analyse real life problems. The deciding factors for chikungunya, diabetes and flu are found using the algorithm.**

***Keywords*— Rough sets, Rough topology, Lower approximations, Upper approximations and Core.**

I. INTRODUCTION

The Rough set theory introduced by Pawlak plays an important role in the fields of decision analysis, data analysis, pattern recognition etc. Rough set theory is used as a tool for representing, reasoning and decision making in the case of uncertain information. Rough topology in terms of approximations and boundary region of a subset of an universe using an equivalence relation on it was introduced by Lellis Thivagar et.al.[3]. The concept of topological basis is used to find the deciding factor for chikungunya, diabetes and flu.

II. PRELIMINARIES

Definition 2.1[5] Let U be a non-empty finite set of objects called the universe and R be an equivalence relation on U named as the indiscernibility relation. Then U is divided into disjoint equivalence classes. Elements belonging to the same equivalence class are said to be indiscernible with one another. The pair (U,R) is said to be the approximation space. Let $X \subseteq U$.

(i) The lower approximation of X with respect to R is the set of all objects, which can be for certain classified as X with respect to R and it is denoted by $L_R(X)$.

$L_R(X)=\bigcup_{x\in U}\{R(x): R(x)\subseteq X\}$ where R(x) denotes the equivalence class determined by $x \in U$

(ii) The upper approximation of X with respect to R is the set of all objects, which can be possibly classified as X with respect to R and it is denoted by $U_R(X)$.

$U_R(X) = \bigcup_{x\in U}\{R(x): R(x)\subseteq X\}$

(iii)The boundary region of X with respect to R is the set of all objects, which can be classified neither as X nor as X with respect to R and it is denoted by $B_R(X)$. That is $B_R(X)= U_R(X) - L_R(X)$.

Definition 2.2[3] Let U be a non-empty, finite universe of objects and R be an equivalence relation on U. Let $X\subseteq U$. Let $\tau_R(X)=\{\phi, U, L_R(X), U_R(X), B_R(X)\}$. Then $\tau_R(X)$ is a topology on U called as the rough topology with respect to X. Elements of the rough topology are known as the rough-open sets in U and (U, τ_R,X) is called the rough topological space.

Remark 2.3[3] If τ_R is the rough topology on U with respect to X, then the set

β_R={U, $L_R(X)$, $B_R(X)$ } is the basis for τ_R

Definition2.3[3] Let U be the universe and R be an equivalence relation on U. Let τ_R be the rough topology on U and β_R be the basis for τ_R. A subset M of A, the set of attributes is called the core of R if $\beta_M \neq \beta_{R-r}$ for every r in M. That is, a core of R is subset of attributes which is such that none of its elements can be removed without affecting the classification of attributes.

III. INDISERNIBILITY MATRIX

The indisernibility matrix of the basis B= β_R of the rough topology for the sets other than U is either a 2x2 matrix or a 1 x 1 matrix defined as $(c_{ij})= \{a\in B: a(x_i)=a(x_j)\}$ for i,j=1,2. The indisernibility matrix M(B) assigns to each pair of objects x and y a subset of attributes $\delta(x,y) \subseteq B$[5]. Core is the set of all single element entries of the indiscerniblity matrix M(B). CORE(B)=$\{a\in B: c_{ij}=\{a\}$, for some i,j} . Every indisernibilty matrix M(B) defines a indisernibilty function f(B) defined by the formula F(B)= $\prod_{(x,y)\in U^2}\{\sum\delta(x,y):(x,y)\in U^2 and \delta(x,y)\neq\phi\}$[5].

IV. ALGORITHM

Step1: Given a finite universe U, a finite set A of attributes that is divided into two classes , C of condition attributes and D of decision attributes, an equivalence relation R on U corresponding to C and a subset X of U, represent the data as an information table, columns of which are labelled by attributes, rows by objects and entries of the table are attribute values.
Step2: Find the lower approximation, upper approximation and the boundary region X with respect to R.
Step 3:Generate the rough topology τ_R and its basis β_R .
Step 4: Form the indisernibility matrix.
Step 5:Find the unique indiscernibility function which gives the CORE.
Applying the indiscerniblity matrix M(B) for the basis of the rough topology, three cases are discussed in the next section. The basis of the rough topology contains either two sets or one set other than the universe U. The three examples are based on two types of basis of the rough topology.

V.INDINISERBILITY MATRIX FOR CHIKUNGUNYA

Chikungunya is a diseases transmitted to humans by virus-carrying Ades mosquitoes. It causes fever and severe joint pain. Other symptoms are similar to dengue fever. The following table gives information of 8 patients.

Patients	Joint pain(J)	Head ache(H)	Nausea(N)	Temparature(T)	Chikungunya
P1	Yes	Yes	Yes	Yes	Yes
P2	Yes	No	No	Yes	No
P3	Yes	No	No	Yes	Yes
P4	No	No	No	Yes	No
P5	No	No	No	Yes	No
P6	Yes	Yes	No	Yes	Yes
P7	Yes	Yes	No	No	No
P8	Yes	Yes	No	Yes	Yes

The columns of the table represent the attributes(the symptoms for chikununya) and the rows represent the objects(the patients). The equivalence classes for the attributes Joint pain,Headache, Nausea and Temperature are{P1} , $\{P_2,P_3\}$, $\{P_4,P_5\}$, $\{P_6,P_8\}$, $\{P_7\}$. X=$\{P1,P_3,P_6,P_8\}$ be the set of patients having Chikungunya and U is the set of all 8 patients. For the set of patients having Chikungunya the lower approximation =$\{P1,P_6,P_8\}$ and the upper approximation ={P1,P2,P3,P6,P8} and the boundary region ={P2,P3} The rough topology τ_R={U, ϕ ,$\{P1 ,P_6,P_8\}$ {P1,P2,P3,P6,P8} , {P2,P3} } and the basis of the rough topology is β_R ={U, $\{P1,P_6,P_8\}$,{P2,P3} } . Let E2=$\{P2,P_3\}$, E1=$\{P_1,P_6,P_8\}$. The indisernibility matrix M(B) for the basis is given by

	E1	E2
E1	J+N+T	J+T
E2		ϕ

In the table J,H,T denote Joint pain, Nausea, Temperature. The indisernibility function for the table is (J+H+T)(J+T) where + denotes the Boolean sum and the bracket denotes the Boolean multiplication. After simplification the final expression is J+T and hence the core is Joint pain and Temperature for the disease Chikungunya.

Observation: Joint Pain and Temperature are the key attributes to decide whether a patient has chikungunya or not.

VI.INDISERNIBILITY MATRIX FOR DIABETES

Diabetes is a a group of metabolic diseases in which a person has high blood sugar, either because the body does not produce enough insulin, or because cells do not respond to the insulin that is produced. In diabetes , glucose in the blood can not move in to cells, so it stays in the blood. This not only harms the cells that need the glucose for fuel, but also harms certain organs and tissues exposed to the high glucose levels.. This high blood sugar produces the classical symptoms of polyuria(frequent urination), weight loss and polyphagia(increased hunger).

The following table gives information of 6 patients

Patients	Frequent Urination(F)	Weight Loss(W)	Increased Hunger	Diabetes
P1	Yes	Yes	No	Yes
P2	Yes	No	Yes	Yes
P3	Yes	No	No	Yes
P4	No	Yes	Yes	No
P5	No	Yes	No	No
P6	No	No	Yes	No

Here U= ={P1,P_2,P_3,P_4 ,P_5,P_6} , X=={P_1,P_2,P_3} be the set of patients having diabetes. The equivalence classes for the attributes Frequent Urination, Weight Loss and Increased Hunger are{ P_1},{P_2}{P_3},{P_4},{P_5},{P_6}. The lower approximation of X ={P_1 ,P_2,P_3}, the upper approximation ={P_1 ,P_2 ,P_3} and the boundary region= ϕ . The rough topology on U ={U, ϕ ,{P_1,P_2,P_3}} and its basis β_R ={U, {P1,P_2,P_3}} . Here the basis consists on only one element other than U and it is denoted by E1={P_1,P_2,P_3}.

The indisernibility matrix M(B) for the basis is given by

	E1
E1	F

The indisernibility function for the table is F. Hence the CORE={F}.

Observation: Since the core has F as its only element Frequent Urination is the key attribute that has close connection to the disease diabetes.

VII. INDINISERBILITY MATRIX FOR FLU

The following table gives information of 6 patients suffering from Flu.

Patients	Headache(H)	Temperature(T)	Flu
P1	No	Yes	Yes
P2	Yes	Yes	Yes
P3	Yes	Yes	Yes
P4	No	No	No
P5	Yes	No	No
P6	No	Yes	Yes

Here U={P1,P_2,P_3,P_4,P_5,P_6} ,X={P1,P_2,P_3,P_6} be the set of patients having Flu. The equivalence classes for the attributes Head ache(H) and Temperature(T) are { P_1,P_6} ,{P_2,P_3} ,{P_4} ,{P_5} . The lower approximation of X ={P1,P_2,P_3,P_6} , the upper approximation of X={P1,P_6,P_2,P_6} and the boundary region= ϕ . The rough topology on U ={U, ϕ ,{P_1,P_2,P_3,P_6} } and its basis β_R ={U, {P_1,P_2,P_3,P_6} } . Here the basis consists on only one element other than U and it is E1={P_1,P_2,P_3,P_6}.

The indisernibility matrix M(B) for the basis is given by

	E1
E1	T

The indisernibility function for the table is T. Hence the core is Temperature.

Observation: Since the core has T as its only element, Temperature is the key attribute that has connection to the disease Flu.

VIII. CONCLUSION.

Thus using the basis of the rough topology and the indisernibility matrix M(B) the core factors for three diseases are found. The rough topology can be applied to more information systems for future research. The rough topology can be used as a tool to analyse qualitative attributes. Hence it is advantageous to use rough topology in real life situations.

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