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Decision Making Using Rough Topology and Indiscernibility Matrix for Diagnosing Disease

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ABSTRACT

Rough set theory has provided the necessary formalism and ideas for the development of some propositional machine learning systems. An important feature of rough sets is that the theory is followed by practical implementations of toolkits that support interactive model development. The main objective of this paper is to introduce and analyze the Rough Set Theory and also to decide the factors for diseases by using Indiscernibility and Boolean law.

Keywords : Rough Sets, Set Approximation, Equivalence Class, Basis, Indiscernibility Matrix.

I. INTRODUCTION

Zdzislaw I. Pawlak introduced the theory of rough sets as an extension of set theory for the study of intelligent systems characterized by insufficient and incomplete information. Rough Sets Theory is one of many mathematical approaches to handle imprecision and uncertainty. Rough set theory is an efficient model to capture uncertainty in data and the processing of data using rough set techniques is easy and convincing.

II. PRELIMINARIES

2.1 ROUGH SETS:

Rough set concept can be defined by means of topological operations, interior and closure, approximations. 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 $X \subseteq U$.

2.2 LOWER APPROXIMATION:

The set of all objects which can be with certainty classified as members of X with respect to R is called the R-lower approximation of a set X with respect to R, and denoted by $R_L(X)$,

$$\text{i.e. } R_L(X) = \{x : R(x) \subseteq X\}$$

2.3 UPPER APPROXIMATION:

The set of all objects which can be only classified as possible members of X with respect to R is called the R-upper approximation of a set X with respect to R, and denoted by $R_U(X)$,

$$\text{i.e. } R_U(X) = \{x : R(x) \cap X \neq \emptyset\}$$

2.4 BOUNDARY REGION:

The set of all objects which can be decisively classified neither as members of X nor as members of X with respect to R is called the boundary region of a set X with respect to R, and denoted by RN_R (X),

i.e. $RN_R(X) = R_U(X) - R_L(X)$

2.5 INDISCERNIBILITY MATRIX:

The same or indiscernible objects may be represented several times, or some of the attributes may be superfluous. A binary relation R(x) ⊆ X×X which is reflexive (if an object is in relation with itself xRx), symmetric (if xRy then yRx) and transitive (if xRy and yRz then xRz) is called an equivalence relation. The equivalence class of an element x∈X consists of all objects y∈X such that xRy. Let A = (U, A) be an information system, then with any B ⊆A there is associated an equivalence relation I(B):

$$I(B) = \{(x, x') \in U^2 | \forall a \in B\ a(x) = a(x')\}$$

I(B) is called the Indiscernibility relation.

III. EYE CANCER

Table 1

PATIENT NO	A	B	C	D	E	DECISION
N1	Yes	No	Yes	Yes	Yes	Yes
N2	Yes	No	No	Yes	Yes	No
N3	No	Yes	No	No	No	No
N4	Yes	Yes	No	Yes	Yes	Yes
N5	No	Yes	No	No	No	No
N6	Yes	Yes	Yes	Yes	Yes	Yes
N7	Yes	No	No	Yes	Yes	Yes
N8	No	Yes	Yes	No	No	No
N9	Yes	No	No	No	Yes	No

A - Blurred Vision
B - Dark Patch in eye
C - Bulging of eye
D - Lump on eye
E - Full/ Partial loss of eye

3.1 EQUIVALENCE CLASS:

{N1}, {N2, N7}, {N3, N5}, {N4}, {N6}, {N8}, {N9}

3.2 LOWER APPROXIMATION (R_L):

{N1, N4, N6}

3.3 UPPER APPROXIMATION (R_U):

{N1, N2, N4, N6, N7}

3.4 BOUNDARY REGION (RN_R):

{N2, N7}

3.5 ROUGH TOPOLOGY (Ʈ):

Ʈ= {U, Ø, R_L, R_U, RN_R}

Ʈ= {U, Ø, {N1, N4, N6}, {N1, N2, N4, N6, N7}, {N2, N7}}

3.6 BASIS:

ß = {U, Ø, R_L, RN_R }

ß = {U, Ø, {N1, N4, N6}, {N2, N7}}

3.7 INDISCERNIBILITY MATRIX:

Let X_1 = {N1, N4, N6}

X_2= {N2, N7}

Table 2

	X_1	X_2
X_1	A+D+E	D+E
X_2	-	Ø

By using Boolean law,

→ (A + D + E) (D + E)

→ AD + DD + ED + AE + DE + EE

→ AD + D + ED + AE + DE + E

→ D (A + 1) + ED + AE + E (D+1)

→ D + ED + AE + E

→ D (1 + E) + E (A+1)

→ D + E

Therefore, lump on eye and the partial loss of vision are the attributes that decides the disease.

IV. GLAUCOMA

Table 3

PATIENT NO	A	B	C	D	DECISION
N1	Yes	No	No	Yes	Yes
N2	No	Yes	Yes	No	No
N3	Yes	No	Yes	Yes	Yes
N4	Yes	Yes	Yes	Yes	Yes
N5	Yes	No	No	Yes	No

A- Severe eye pain

B- Head ache

C- Profuse tearing

D- Blurred vision/ Haloes

4.1 EQUIVALENCE CLASSES:

{N1, N5}, {N2}, {N3}, {N4}

4.2 LOWER APPROXIMATION (R_L):

{N3, N4}

4.3 UPPER APPROXIMATION (R_U):

{N1, N3, N4, N5}

4.4 BOUNDARY REGION (RN_R):

{N1, N5}

4.5 ROUGH TOPOLOGY (Ʈ)

Ʈ = {U, Ø, R_L, R_U, RN_R}

Ʈ = {U, Ø, {N3, N4}, {N1, N3, N4, N5}, {N1, N5}}

4.6 BASIS:

ß = {U, Ø, R_L, RN_R}

ß = {U, Ø, {N3, N4}, {N1, N5}}

4.7 INDISCERNIBILITY MATRIX:

Let X_1 = {N3, N4}

X_2 = {N1, N5}

Table 4

	X_1	X_2
X_1	A+C+D	A+D
X_2	-	Ø

By using Boolean law,

→ (A+C+D) (A+D)

→ AA + CA + DA + AD + CD + DD

→ A + CA + DA + AD + CD + D

→ A (1 + C) + DA + AD + D (C + 1)

→ A + DA + AD + D
→ A (1 + D) + D (A + 1)
→ A + D

Therefore, severe eye pain and blurred vision/ haloes are the attributes that decides the disease.

V. CONCLUSION

Rough sets may be described by using the notion of rough membership functions. Rough set has also been used for knowledge representation; data mining; dealing with imperfect data; reducing knowledge representation and for analyzing attribute dependencies. The concept of basis has been applied to find the deciding factors of a recent outbreak 'Eye cancer' and 'Glaucoma' which had been reported especially, in South India. We could find that Lump on eye and Partial loss of vision is the deciding factors for Eye Cancer. Severe eye pain and Blurred vision/Haloes are the deciding symptom for glaucoma. It is also seen that from a clinical point of view, the rough topological model is on par with the medical experts with respect to the diseases analyzed here.

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