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Diagnostics of Gastrointestinal Diseases Using Nanotopology

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Abstract

In this paper, we used the basis of nano-topological space to find out more causes of gastrointestinal diseases, Data were collected for patients suffering from digestive problems in the Gastroenterology Department of Tripoli Medical Center in Tripoli, State of Libya (Table 1) and Here we applyed the nano topology in conjunction with clinical studies to find the key factors of digestive problems using topological reduction of attributes in incomplete information system, the table in this paper gives information about patients "diabetes, blood pressure, drinking Coffee or Smoking, Playing sports and Heart" these factors have been studied and were placed in the form of nanogroups in a nanotopological space, the purpose of this study is to know how to avoidance of pathogens of the system digestive system to reduce the incidence of this disease, by using approximate voids in nano-topological space.

Keywords

Gastrointestinal, Topological space, Approximation space, lower approximation, upper approximation, boundary region, Nano topology

1. Introduction

Topology is a branch of mathematics and this branch was established at the beginning of the twentieth century, which had been developed from 1925 to 1975, It has recently discovered what is known as the nano-topological space, and it was given this name due to its small size, it contains five elements of subgroups of space at most, and nano-topology has been used in medical diagnosis, analysis and decision-making.

L.Thivagar et al. [1] introduced the concept of nan-topological spaces which was defined in terms of approximations and boundary region of a subset of a universe U using an equivalence relation on it and also defined nano closed sets, nano interior and nano closure.

A. Jayalakshmi et al. [2] introduced the Ngrα-closed set and discussed some of its properties as well as he identified the risk factors that cause heart attack through the concept of nano-topology, in previous studies some diseases were diagnosed using approximation in nano-spaces.

In this research, the collected data were divided into two groups, the first group of patients suffering from digestive problems, and the data included in (Table 1) were taken, and the second group did not have problems with the digestive system.

And we analyzed the data for each group using the nano-topological space, and it was by comparing the basis of the nano-topological space for all cases, and the results were extracted for these data as shown in this research, and was the aim of this research is to find out the causes of digestive system problems by using approximate voids in nano-topological space.

2. Preliminaries

2.1. Definition [4]

A topology on a non empty set X is a collection τ of subsets of X having the following the properties:-
i) X and φ are in τ
ii) The union of the elements of any sub collection of τ is in τ.
iii) The intersection of the elements of any finite sub collection of τ is in τ.
A set X for which a topology τ has been specified is called a Topological Space.

2.2 Definition

A binary relation R on a set **X** is said to be an equivalence relation, if and only if it is reflexive, symmetric and transitive.

2.3 Definition [5], [6]:

Let U be a non-empty finite set of objects called the universe R 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.

2.4 Definition [5]:

For the pair of approximation space (U, R) where U is the universe, and R be an binary relation on U. Then the set xR is defined as $xR = \{y \in U,\ xRy\}$is called as the right neighborhood of an element $x \in U$.

2.5 Example [5]:

Let $U = \{a, b, c, d\}$, with $R = \{(a, a), (b, b), (c, b), (c, c), (c, d), (d, a)\}$, Then we have $aR = \{a\}, bR = \{b\}$,
$cR = \{b, c, d\}$,$dR = \{a\}$ and $Ra = \{a, d\}$, $Rb = \{b, c\}$, $Rc = \{c\}$, $Rd = \{c\}$.

2.6 Definition:

If the pair (U, R) is the approximation space and let $X \subseteq U$, then [6]:
(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 $L_R(X)$. That is $L_R(X) = \cup_{x\in U}\{R(x): R(x) \subseteq X\}$, 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 $U_R(X)$.
That is $U_R(X) = \cup_{x\in U}\{R(x): R(x) \cap X \neq \varphi\}$.
(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 not $- X$ with respect to R and it is denoted by $B_R(X)$. That is, $B_R(X)$=$U_R(X)$- $L_R(X)$.

2.7 Property [7]:

If (U, R) is an approximation space and $X, Y \subseteq U$, then
(i) $L_R(X) \subseteq X \subseteq U_R(X)$
(ii) $L_R(\varphi) = U_R(\varphi) = \varphi$ and $L_R(U) = U_R(U) = U$
(iii) $U_R(X \cup Y) = U_R(X) \cup U_R(Y)$
(iv)$U_R(X \cap Y) = U_R(X) \cap U_R(Y)$
(v) $L_R(X \cup Y) = L_R(X) \cup L_R(Y)$
(vi) $L_R(X \cap Y) = L_R(X) \cap L_R(Y)$
(vii) $L_R(X) \subseteq L_R(Y)$and$U_R(X) \subseteq U_R(Y)$ whenever $X \subseteq Y$
(viii) $U_R(X^c) = [L_R(X)]^c$and$L_R(X^c) = [U_R(X)]^c$
(ix) $U_R U_R(X) = L_R U_R(X) = U_R(X)$
(X) $L_R L_R(X) = L_R U_R(X) = L_R(X)$

2.8 Definition [8], [2]

Let U be the universe and R be an equivalence relation on U. Then for $X \subseteq U, \tau_R(X) = \{U, \emptyset, L_R(X), U_R(X), B_R(X)\}$ is called the nano topology on U. By property, $\tau_R(X)$ satisfies the following axioms:

(i) U and φ in $\tau_R(X)$.

(ii) The union of the elements of any subcollection of $\tau_R(X)$ is in $\tau_R(X)$.

(iii) The intersection of the elements of any finite subcollection of $\tau_R(X)$ is in $\tau_R(X)$

We call $(U,\tau_R(X))$ is a nano topological space.The elements of $\tau_R(X)$ are called a nano open sets and the complement of a nano open sets is called nano closed sets.

Throughout this paper $(U,\tau_R(X))$ is a nano topological space with respect to X where $X \subseteq U$, R is an equivalence relation on U, U/R denotes the family of equivalence classes of U by R.

2.9 Definition [8]:

Let $(U, \tau_R(X)$ be a nano topological space, the set $\beta = \{U, L_R(X), B_R(X)\}$ is called a bases for the nano topology $\tau_R(X)$ on U with respect to X.

2.10 Example [2]:

Let $U = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8\}, C = \{y_1, y_2, y_3, y_4, y_5\}$
Where the family of equivalence classes, U/C corresponding to C is given by U/R(C)
$=\{\{x_1,x_4\},\{x_2\},\{x_3,x_6\},\{x_5\},\{x_7\},\{x_8\}\}$, and $X = \{x_1, x_2, x_3, x_7\}$, So $L_c(X) = \{x_2, x_7\}$,
$U_c(X) = \{x_1, x_2, x_3, x_4, x_6, x_7\}$ and $B_c(X) = \{x_1, x_3, x_4, x_6\}$.

Therefore, $\tau_c(X) = \{U, \varphi, \{x_2, x_7\}, \{x_1, x_2, x_3, x_4, x_6, x_7\}, \{x_1, x_3, x_4, x_6\}\}$. The basis of $\tau_c(X)$ is given by $\beta_c(X) = \{U, \{x_2, x_7\}, \{x_1, x_3, x_4, x_6\}\}$.

2.11 Definition [8][1]:

If $(U, \tau_R(X)$ be a nano topological space with respect to X, where $X \subseteq U$ and if $A \subseteq U$ then

(i) The nano interior of the set A is defined as the union of all nano open subsets contained in A, and is denoted by nint(A).

(ii) The nano closure of the set A is defined as the intersection of all nano closed subsets containing A, and is denoted by ncl(A).

3. Application of nano topology

3.1 Example:

Here we apply the nano topology to find the key factors of "Gastrointestinal diseases" using topological reduction of attributes in incomplete information system.The following (Table 1) gives information about these patients Those with Diabetics, Playing sports,High Blood Pressure, Coffee or smoking and Heart.

Table 1

	Name	Diabetics	Playing sports	High blood pressure	Coffee or Smoking	Heart	Gastrointeshinal
P_1	S. S. M	No	No	No	Yes	No	No
P_2	E. Y. SH	No	No	No	No	No	No
P_3	A .F. A	No	No	No	No	No	No
P_4	M. A A,	Yes	Yes	Yes	Yes	Yes	Yes
P_5	K. M. E	Yes	No	Yes	No	No	Yes
P_6	M. A. B	No	No	No	Yes	No	No
P7	S. A. A.	Yes	No	Yes	No	Yes	Yes
P_8	A. E. E.	No	No	No	Yes	No	Yes

Here $U = \{P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8\}$, the set of patients and A ={Diabetics,Playing sports,High Blood Pressure, Coffee or smoking, Heart, Gastrointestinal}, which is divided into two classes, $C = \{D, PS, BP, CS, H\}$ and W={Gastrointestinal}, such that D is Diabetics, PS is Playing sports, BP is High Blood Pressure, CS is Coffee or smoking and H is Heart. The family of equivalence classes, U/C corresponding to C is given by U/R(C) = $\{\{P_2, P_3\}, \{P_1, P_6, P_8\}, \{P_5\} \{P_7\}, \{P_4\}\}$.

3.1.1 Case1: (Patients with Gastrointestinal)

Let $X = \{P_4, P_5, P_7, P_8\}$, the set of patient with Gastrointestinal. Then $L_c(X) = \{P_4, P_5, P_7\}$, $U_c(X) = \{P_1, P_4, P_5, P_6, P_7, P_8\}$ and $Bc(X) = \{P_1, P_6, P_8\}$. Therefore, $\tau_c(X) = \{U, \varphi, \{P_4, P_5, P_7\}, \{P_1, P_4, P_5, P_6, P_7, P_8\}, \{P_1, P_6, P_8\}$. The basis of $\tau_c(X)$ is given by $\beta_c(X) = \{U,), \{P_4, P_5, P_7\}, \{P_1, P_6, P_8\}\}$.

Step1: When the attribute 'Diabetics' is removed from C, U/*R*(C-D) = $\{\{P_2, P_3\}, \{P_1, P_6, P_8\}, \{P_4\}, \{P_5\}, \{P_7\}\}$ and hence the lower and upper approximations of X corresponding to C-{D} are given by $L_{c-\{D\}}(X) = \{P_4, P_5, P_7\}$, $U_{c-\{D\}}(X) = \{P_1, P_4, P_5, P_6, P_7, P_8\}$and the corresponding boundary region is $B_{c-\{D\}}(X) = \{P_1, P_6, P_8\}$ Therefore, the corresponding nano topology and its basis are given by $\tau_{c-\{D\}}(X) = \{U, \varphi, \{P_4, P_5, P_7\}, \{P_1, P_4, P_5, P_6, P_7, P_8\}, \{P_1, P_6, P_8\}\}$ and $\beta_{c-\{D\}}(X) = \{U, \{P_4, P_5, P_7\}, \{P_1, P_6, P_8\}\} = \beta_c(X)$.

Step2: When the attribute "Playing sports" is removed from $C, U/R(C - PS) = \{\{P2, P3\}, \{P4\}, \{P1, P6, P8\}, \{P5, P7\}\}$ and hence the lower and upper approximations of X corresponding to $C - \{PS\}$ are given by $L_{c-\{PS\}}(X) = \{\{P_4, P_5, P_7\}, U_{c-\{PS\}}(X) = \{P_1, P_4, P_5, P_6, P_7, P_8\}$, and the corresponding boundary region is $B_{c-\{PS\}}(X) = \{P_1, P_6, P_8\}$. Therefore, the corresponding nano topology and its basis are given by $\tau_{c-\{PS\}}(X) = \{P_4, P_5, P_7\}, \{P_1, P_4, P_5, P_6, P_7, P_8\}, \{P_1, P_6, P_8\}\}$ and $\beta_{c-\{PS\}}(X) = \{U, \{P4, P5, P7\}, \{P1, P6, P8\} = \beta_c(X)$.

Step3: When the attribute "High Blood Pressure" is removed from C, $U/R(C - BP) = \{\{P_2, P_3\}, \{P_4\}, \{P_1, P_5, P_8\}, \{P_5\}, \{P_7\}\}$ and hence the lower and upper approximations of X corresponding to $C - \{BP\}$ are given by $L_{c-\{BP\}}(X) = \{P_4, P_5, P_7\} U_{c-\{BP\}}(X) = \{P_1, P_4, P_5, P_6, P_7, P_8\}$ and the corresponding boundary region is $B_{c-\{BP\}}(X) = \{P_1, P_6, P_8\}$. Therefore, the corresponding nano topology and its basisare given by $\tau_{c-\{BP\}}(X) = \{\{P_4, P_5, P_7\}, \{P_1, P_4, P_5, P_6, P_7, P_8\}, \{P_1, P_6, P_8\}$ and $\beta_{c-\{BP\}}(X) = \{U, \{P4, P5, P7\}, \{P1, P6, P8\} = \beta_c(X)$

Step4: When the attribute "Coffee or Smoking" is removed from $C, U/R(C - CS) = \{\{P1, P2, P3, P6, P8\}, \{P4\}, \{P5\}, \{P7\}\}$ and hence the lower and upper approximations of X corresponding to $C - \{CS\}$ are given by $L_{c-\{CS\}}(X) = \{\varphi\}, U_{c-\{CS\}}(X) = \{P1, P2, P3, P4, P5, P6, P7, P8\}$, and the corresponding boundary region is $B_{c-\{CS\}}(X) = \{P1, P2, P3, P4, P5, P6, P7, P8\}$, Therefore, the corresponding nano topology and its basis are given by $\tau_{c-\{CS\}}(X) = \{U, \varphi\}$, and $\beta_{c-\{CS\}}(X) = \{U, \{P1, P2, P3, P4, P5, P6, P7, P8\}\} \neq \beta_c(X)$

Step5: When the attribute "Heart" is removed from $C, U/R(C - H) = \{\{P2, P3\}, \{P1, P6, P8\}, \{P4\}, \{P5, P7\}\}$ and hence the lower and upper approximations of X corresponding to $C - \{H\}$ are given by $L_{c-\{H\}}(X) = \{P4, P5, P7\}, U_{c-\{H\}}(X) = \{P1, P4P5, P6, P7 P8\}$, and the corresponding boundary region is $B_{c-\{H\}}(X) = \{P1, P6, P8\}$. Therefore, the corresponding nano topology and its basis are given by

$$\tau_{c-\{H\}}(X) = \{U, \varphi, \{P4, P5, P7\}, \{P1, P4P5, P6, P7 P8\}, \{P1, P6, P8\}\}$$

and $\beta_{c-\{H\}}(X) = \{U, \{P4, P5, P7\}, \{P1, P6, P8\}\} = \beta_c(X)$

Therefore, CORE = { Coffee or Smoking}

3.1.2 Case2: (Patients not with Gastrointestinal)

Let $X = \{P1, P2, P3, P6\}$, the set of patient not with Gastrointestinal. Then $L_c(X) = \{P2, P3\}, U_c(X) = \{P1, P2, P3, P6, P8\}$ and $Bc(X) = \{P1, P6, P8\}$.

Therefore, $\tau\_c(X) = \{U, \varphi, \{P2, P3\}, \{P1, P2, P3, P6, P8\}, \{P1, P6, P8\}\}$. The basis of $\tau_c(X)$ is given by $\beta_c(X) = \{U, \{P2, P3\}, \{P1, P6, P8\}\}$.

Step1: When the attribute 'Diabetics' is removed from $C, U/R(C - D) = \{\{P2, P3\}, \{P1, P6, P8\}, \{P4\}, \{P5\}, \{P7\}\}$ and hence the lower and upper approximations of X corresponding to $C - \{D\}$ are given by $L_{c-\{D\}}(X) = \{\{P2, P3\}\}, U_{c-\{D\}}(X) = \{P1, P2, P3, P6, P8\}$ and the corresponding boundary region is $B_{c-\{D\}}(X) = \{P1, P6, P8\}$. Therefore the corresponding nano topology and its basis are given by $\tau_{c-\{D\}}(X) = \{U, \varphi, \{P2, P3\}, \{P1, P2, P3, P6, P8\}, \{P1, P6, P8\}and\beta_{c-\{D\}}(X) = \{U, \{P2, P3\}, \{P1, P6, P8\}\}$, So $\beta_{c-\{D\}}(X) = \beta_c(X)$.

Step2: When the attribute "Playing sports" is removed from $C, U/R(C - PS) = \{\{P2, P3\}, \{P4\}, \{P1, P6, P8\}, \{P5, P7\},\}$ and hence the lower and upper approximations of

X corresponding to $C-\{PS\}$ are given by $L_{c-\{PS\}}(X)=\{P2,P3\}, U_{c-\{PS\}}(X)=\{P1,P2,P3,P6,P8\}$, and the corresponding boundary region is $B_{c-\{PS\}}(X)=\{P1,P6,P8\}$. Therefore, the corresponding nano topology and its basis are given by

$\tau_{c-\{PS\}}(X)=\{U,\varphi,\{P2,P3\},\{P1,P2,P3,P6,P8\},\{P1,P6,P8\}\}$ and $\beta_{c-\{PS\}}(X)=\{U,\{P2,P3\},\{P1,P6,P8\}$ So $\beta_{c-\{PS\}}(X)=\beta_c(X)$

Step3: When the attribute 'High Blood Pressure' is removed from $C, U/R(C-BP)$ $\{\{P2,P3\},\{P4\},\{P1,P6,P8\},\{P5\},\{P7\}\}$ and hence the lower and upper approximations of X corresponding to $C-\{BP\}$ are given by $L_{c-\{BP\}}(X)=\{P2,P3\}U_{c-\{BP\}}(X)=\{P1,P2,P3,P6,P8\}$, and the corresponding boundary region is $B_{c-\{BP\}}(X)=\{P1,P6,P8\}$. Therefore, the corresponding nano topology and its basisare given

by $\tau_{c-\{BP\}}(X)=\{U,\varphi,\{P2,P3\},\{P1,P2,P3,P6,P8\},\{P1,P6,P8\}$ and $\beta_{c-\{BP\}}(X)=\{U,\{P2,P3\},\{P1,P6,P8\}\}=\beta_c(X)$

Step4: When the attribute "Coffee or Smoking" is removed from C, $U/R(C-CS)=\{\{P1,P2,P3,P6,P8\},\{P4\},\{P5\},\{P7\}\}$ and hence the lower and upper approximations of X corresponding to $C-\{CS\}$ are given by$L_{c-\{CS\}}(X)=\{\varphi\}, U_{c-\{CS\}}(X)=\{P1,P2,P3,P6,P8\}$, and the corresponding boundary region is $B_{c-\{CS\}}(X)=\{P1,P2,P3,P6,P8\}$. Therefore, the corresponding nano topology and its basis are given by $\tau_{c-\{CS\}}(X)=\{U,\varphi,\{P1,P2,P3,P6,P8\}$ and $\beta_{c-\{CS\}}(X)=\{U,\{P1,P2,P3,P6,P8\}\}\neq\beta_c(X)$

Step5: When the attribute "Heart" is removed from $C, U/R(C-H)=\{\{P2,P3\},\{P1,P6,P8\},\{P4\},\{P5,P7\}\}$ and hence the lower and upper approximations of X corresponding to $C-\{H\}$ are given by

$L_{c-\{H\}}(X)=\{P2,P3\}, U_{c-\{H\}}(X)=\{P1,P2,P3,P4P6,P8\}$, and the corresponding boundary region is $B_{c-\{H\}}(X)=\{P1,P6,P8\}$. Therefore, the corresponding nano topology and its basis are given by

$\tau_{c-\{H\}}(X)=\{U,\varphi,\{P2,P3\},\{P1,P2,P3,P6,P8\},\{P1,P6,P8\}\}$ and $\beta_{c-\{H\}}(X)=\{U,\{P2,P3\},\{P1,P6,P8\}\}=\beta\_c(X)$

Therefore, CORE = { Coffee or Smoking}

Result: In this study, we found that drinking coffee or smoking is the most harmful to the digestive system, and thus from nano topology science, diseases of the digestive system can be avoided by reducing the consumption of drinking coffee and smoking.

So can diagnose any disease and identify the factors that cause that disease by using nano topology.

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