Article

Modeling Analysis of COVID-19 in View Point of Rough Topology

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Abstract: Work done by us shows that rough topology is a good tool for dealing with things that happen in the real world. The concept of "basis" has been used to show out the deciding elements of the recent outbreak of COVID-19 that was reported all over the world.

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1. Introduction and Preliminaries

Rough set is a novel mathematical technique for dealing with ambiguity in knowledge-based systems, market research, and information systems [1]. This concept has several applications in domains such as medical diagnosis and economics. Other rough sets models were shown in [1,2,3,4, 5,6,7, 11, 16, 25, 26, 35, 38, 39, 44, 45, 49, 50, 51].

There was no human event that was able to restrict the face of life on the earth in a significant and continuous manner. But if we look at the emerging corona virus (Covid-19) which hardly has any weight, as specialists said that the weight of all corona viruses that infected millions in the world does not reach only two grams, so it had a stronger effect than atomic weapons, and then the Talking about Corona, which killed and infected millions in the world does not stop at just looking for a cure, but also about the aftershocks and effects that it leaves sooner or later, the signs of which appeared since the virus began to spread in all countries of the world most of which raised the slogan of myself. With the increasing information available now about the Corona virus, scientists are now working on using modern tools and techniques to be able to analyze the numbers, as a laboratory at the University of California, in cooperation with the Energy Lab, creates new algorithms using mathematical programming tools and computers so that the analysis process at the present time for the Corona virus epidemic is more feasible and effective. Scientists' efforts and response to the Corona pandemic: Clear fingerprints made by scientists and researchers in virology from all over the world in the face of the emerging Covid-19, which the world has joined together with all its capabilities to reach a treatment or vaccine for it since its appearance in December 2019 in Wuhan, China, and its spread throughout the world, causing deaths and injuries by millions. The current research is conducted on several axes: The first axis: related to vaccine research, which sets the end points for this nightmare, and healthy people will have to prevent it. As for the parallel axis, it is the discovery of the medicine that the patient takes to recover from the virus, and in this regard, some recommended medicines have been authorized for the treatment of other diseases. Currently , the appearance of a new human COVID-19, has become a major public health concern due to its ability to cause many respiratory tract infections in people. Human-to-human transmissions have been reported with incubation times ranging from 2 to 10 days, making it easier for the virus to transmit through droplets, contaminated hands, or contaminated surfaces. From a research [9], Human corona viruses can survive for up to

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9 days on nonliving surfaces. Most two impact factors for infections transmission namely Contact with infected surfaces and Interactions with infected people of the virus. In the present section, we introduce an application to show how our approaches are the best tools in decision making about the infection of COVID-19. Accordingly, numerous researchers have published numerous articles on this pernicious virus (for instance, see the references [8–13][13, 24, 27, 28, 40, 41]) and their literatures. COVID-19 has emerged as a deadly virus. This lethal virus has engulfed the entire world, and many individuals have accepted death as a result of this unstoppable bug. With each passing second, the death toll rises. This article seeks to assist in identifying the symptoms that have the most impact on the disease's spread. COVID-19 affects people differently, and some people who get it have mild to moderate symptoms and recover without needing to go to the hospital. A Topology is a subfield of geometry known as rubber sheet geometry. Topology has numerous real-world applications and resolves several issues relating to continuity, either directly or indirectly. Its study does not depend on the dimension, i.e. increasing or decreasing can happen without cutting. Using the neighborhood system, graphs are represented topologically and vice versa for some types of topologies. Recently, graphs, multisets and rough sets are used to represent structures such as the human heart [22], DNA [23] and medicine [24–26]which are useful in medicine, physics, and biology.

Topological concepts play a vital role in rough set may be useful in determining the causes of disease outbreaks and how to treat them. Also studying mutations that occur in genes and diseases and help in finding solutions We use the data set as an information system, mathematical tools and studies to help the expert in decision making. The information systems of people and patients with COVID-19 can be classified via rough set theory and some topological structures. The significance of our paper in studying the critical factors influencing the spread of COVID-19.

In this paper, we have shown that rough topology can be used to solve problems in the real world. The notion of basis has been employed in order to determine the determinants of a recent outbreak of the virus "COVID-19," which has been reported widely throughout the world. In this study, the rough topological model matches up well with medical specialists in terms of clinical use.

2. Preliminaries

Definition 2.1. *[14] Let $\mathfrak{U}$ be a universe of discourse, and R an equivalence relation on U. Then, $\mathfrak{H} = (\mathfrak{U}, \mathfrak{R})$ is called an approximation structure. For any subset $X_1 \subseteq \mathfrak{U}$, is called the lower approximations (L_{app}), upper approximations (U_{app}), are defined as:*

$$L_{app}(X_1) = \{x_1 \in \mathfrak{U} : [x_1]_{\mathfrak{R}} \subseteq X_1\},$$
$$U_{app}(X_1) = \{x_1 \in \mathfrak{U} : [x_1]_{\mathfrak{R}} \cap X_1 \neq \phi\},$$
$$B_R(X_1) = U_{app}(X_1) - L_{app}(X_1).$$

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Proposition 2.2. *[14] If ($\mathfrak{U}$,R) is an approximation structure. and $X_1, Y_1 \subseteq \mathfrak{U}$, then:*
$(i) L_{app}(X_1) \subseteq X_1 \subseteq U_{app}(X_1)$.
$(ii) L_{app}(\phi) = U_{app}(\phi) = \phi and L_{app}(U) = U_{app}U(\phi) = U$.
$(iii) U_{app}(X_1 \cup Y_1) = U_{app}(X_1) \cup U_{app}(Y_1)$.
$(iv) U_{app}(X_1 \cap Y_1) \subseteq U_{app}(X_1) \cap U_{app}(Y_1)$.
$(v) L_{app}(X_1 \cup Y_1) \supseteq L_{app}(X_1) \cup L_{app}(Y_1)$.
$(vi) L_{app}(X_1 \cap Y_1) = L_{app}(X_1) \cap L_{app}(Y_1)$.
$(vii) If X_1 \subseteq Y_1$ *then* $L_{app}(X_1) \subseteq L_{app}(Y_1)$ *and* $U_{app}(X_1) \subseteq U_{app}(Y_1)$.
$(viii) U_{app}(X_1^c) = ([L_{app}(X_1)]^c)$*and* $L_{app}(X_1^c) = ([U_{app}(X_1)]^c)$.
$(ix) U_{app}U_{app}(X_1) = L_{app}U_{app}(X_1) = U_{app}(X_1)$.
$(x) L_{app}L_{app}(X_1) = U_{app}L_{app}(X_1) = L_{app}(X_1)$.

Definition 2.3. *Let $(\mathfrak{U}, \tau)$ be a topological structure. Then $X_1 \subseteq \mathfrak{U}$ is called:*

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i) *α-open* [18] *if* $X_1 \subseteq int(cl(int(X_1)))$.
ii) *γ-open* [20] *if* $X_1 \subseteq cl(int(X_1)) \cup int(cl(X_1))$.
ii) *β-open* [19] *if* $X_1 \subseteq cl(int(cl(X_1)))$.

3. Topological near open sets approximation structure

The necessity to represent subsets of a universe $\mathfrak{U}$ as a base for topology τ motivates the use of topological rough set theory. So, if R is a binary relation on $\mathfrak{U}$, then $K_\tau = (\mathfrak{U}, R_\beta)$ is called near open ($\mathfrak{No}$) approximation structure, where $\beta O(\mathfrak{U})$ is generated by taking R_β as a subbase for τ.

Definition 3.1. *Let* $(\mathfrak{U}, R_\beta)$ *be* $\mathfrak{No}$ *approximation structure,* $X_1 \subseteq \mathfrak{U}$. *Then,* $\underline{R}_\beta(X_1) = \bigcup\{G \in \beta O(\mathfrak{U}) : G \subseteq X_1\}$, $\overline{R}_\beta(X_1) = \bigcap\{F \in \beta C(\mathfrak{U}) : X_1 \subseteq F\}$ *are called* $\mathfrak{No}$ L_{app} *(resp.* $\mathfrak{No}U_{app}$*), where,* $G_{X_1\beta} \in \beta O(\mathfrak{U})$, $X_1 \in G_{X_1\beta}$.

Also, $POS_\beta(X_1) = \underline{R}_\beta(X_1)$ is called the topological + region of X_1, $NEG_\beta(X_1) = \mathfrak{U} - \overline{R}_\beta(X_1)$ is called the topological - region of X_1 and $BND_\beta(X_1) = \overline{R}_\beta(X_1) - \underline{R}_\beta(X_1)$ is called the topological boundary region of X_1. The topological accuracy measure is defined as $\alpha_\beta(X_1) = \frac{|\underline{R}_\beta(X_1)|}{|\overline{R}_\beta(X_1)|}$, where $|\quad|$ represents the cardinality and $X_1 \neq \phi$.

Example 3.2. *Let* $\mathfrak{U} = \{q_1, q_2, q_3, q_4\}$, $R = \{(q_1, q_1), (q_1, q_2), (q_2, q4), (q_3, q_4), (q_4, q_1), (q_4, q_2), (q_4, q_4)\}$ *and* $X_1 = \{q_1, q_2, q_3\}$. *Thus* $q_1R = \{q_1, q_2\}, q_2R = q_3R = \{q_4\}$, $q_4R = \{q_1, q_2, q_4\}$ *and* $\tau = \{\mathfrak{U}, \phi, \{q_1, q_2\}, \{q_4\}, \{q_1, q_2, q_4\}\}$. *Therefore,* $\beta O(\mathfrak{U}) = \{\{q_1\}, \{q_2\}, \{q_3\}, \{q_4\}, \{q_1, q_2\}, \{q_1, q_3\}, \{q_1, q_4\}, \{q_2, q_3\}, \{q_2, q_4\}, \{q_3, q_4\}, \{q_1, q_2, q_3\}, \{q_1, q_2, q_4\}, \{q_1, q_3, q_4\}, \{q_2, q_3, q_4\}\}$. *Then,* $\underline{R}_\beta(X_1) = \{q_1, q_2, q_3\}$ *and* $\overline{R}_\beta(X_1) = \mathfrak{U}$. *The accuracy measure* $\alpha_\beta(X_1) = \frac{3}{4}$.

Proposition 3.3. *Let* $(\mathfrak{U}, R_\beta)$ *be* $\mathfrak{No}$ *approximation structure,* $X_1, Y_1 \subseteq \mathfrak{U}$. *Then :*

(i) X_1 *is* $\mathfrak{No}$ *roughly bottom included in* Y_1 *if* $\underline{R}_\beta(X_1) \subseteq \underline{R}_\beta(Y_1)$,
(ii) X_1 *is* $\mathfrak{No}$ *roughly top included in* Y_1 *if* $\overline{R}_\beta(X_1) \subseteq \overline{R}_\beta(Y_1)$,
(iii) X_1 *is* $\mathfrak{No}$ *roughly included in* Y_1 *if* $\underline{R}_\beta(X_1) \subseteq \underline{R}_\beta(Y_1)$ *and* $\overline{R}_\beta(X_1) \subseteq \overline{R}_\beta(Y_1)$.

Definition 3.4. *Let* $(\mathfrak{U}, R_\beta)$ *be* $\mathfrak{No}$ *approximation structure,* $X_1, Y_1 \subseteq \mathfrak{U}$. *Then :*

(i) R_β*-definable (β-exact) if* $\underline{R}_\beta(X_1) = \overline{R}_\beta(X_1)$ *or* $BND_\beta(X_1) = \phi$,
(ii) $\mathfrak{No}$ *rough if* $\underline{R}_\beta(X_1) \neq \overline{R}_\beta(X_1)$ *or* $BND_\beta(X_1) \neq \phi$.

Definition 3.5. *Let* $(\mathfrak{U}, R_\beta)$ *be* $\mathfrak{No}$ *approximation structure,* $X_1, Y_1 \subseteq \mathfrak{U}$. *Then,* X_1, Y_1 *are :*

(i) $\mathfrak{No}$ *roughly top equal if* $\underline{R}_\beta(X_1) = \underline{R}_\beta(Y_1)$,
(ii) $\mathfrak{No}$ *roughly bottom equal if* $\overline{R}_\beta(X_1) = \overline{R}_\beta(Y_1)$,
(iii) $\mathfrak{No}$ *roughly equal if* $\underline{R}_\beta(X_1) = \underline{R}_\beta(Y_1)$ *and* $\overline{R}_\beta(X_1) = \overline{R}_\beta(Y_1)$.

Proposition 3.6. *If* $(\mathfrak{U}, R_\beta)$ *is* $\mathfrak{No}$ *approximation structure,* $X_1, Y_1 \subseteq \mathfrak{U}$, *then,*

(i) *Every exact set in* $\mathfrak{U}$ *is* $\mathfrak{No}$ *exact ,*
(ii) *Every* $\mathfrak{No}$ *rough set in* $\mathfrak{U}$ *is rough.*

Proof. : Obvious. □

Definition 3.7. *Let* $(\mathfrak{U}, R_\beta)$ *be* $\mathfrak{No}$ *approximation structure,* $X_1 \subseteq \mathfrak{U}$. *Then,* X_1 *is :*

(i) *Roughly* R_β*-definable, if* $\underline{R}_\beta(X_1) \neq \phi$ *and* $\overline{R}_\beta(X_1) \neq \mathfrak{U}$,
(ii) *Internally* R_β*-undefinable, if* $\underline{R}_\beta(X_1) = \phi$ *and* $\overline{R}_\beta(X_1) \neq \mathfrak{U}$,
(iii) *Externally* R_β*-undefinable, if* $\underline{R}_\beta(X_1) \neq \phi$ *and* $\overline{R}_\beta(X_1) = \mathfrak{U}$,

(iv) *Totally R_β-undefinable, if* $\underline{R}_\beta(X_1) = \phi$ *and* $\overline{R}_\beta(X_1) = \mathfrak{U}$,.

Proposition 3.8. *Let* $(\mathfrak{U}, R_\beta)$ *be* $\mathfrak{No}$ *approximation structure,* $X_1, Y_1 \subseteq \mathfrak{U}$. *Then,*

(i) $\underline{R}_\beta(X_1) \subseteq X_1 \subseteq \overline{R}_\beta(X_1)$,
(ii) $\underline{R}_\beta(\phi) = \overline{R}_\beta(\phi) = \phi$, $\underline{R}_\beta(X_1) = \overline{R}_\beta(X_1) = X_1$,
(iii) *If* $X_1 \subseteq Y_1$, *then* $\underline{R}_\beta(X_1) \subseteq \underline{R}_\beta(Y_1)$ *and* $\overline{R}_\beta(X_1) \subseteq \overline{R}_\beta(Y_1)$,
(iv) $\underline{R}_\beta(X_1) \cup \underline{R}_\beta(Y_1) = \underline{R}_\beta(X_1 \cup Y_1)$,
(v) $\overline{R}_\beta(X_1 \cap Y_1) = \overline{R}_\beta(X_1) \cap \overline{R}_\beta(Y_1)$,
(vi) $\underline{R}_\beta(X_1^c) = (\overline{R}_\beta(X_1))^c$,$\overline{R}_\beta(X_1^c) = (\underline{R}_\beta(X_1))^c$,
(vii) $\underline{R}_\beta(\underline{R}_\beta(X_1)) = \underline{R}_\beta(X_1)$, $\overline{R}_\beta(\overline{R}_\beta(X_1)) = \overline{R}_\beta(X_1)$,

Proof. (i) Suppose that $x_1 \in \underline{R}_\beta(X_1)$. Then, $x_1 \in \bigcup\{G \in \beta O(\mathfrak{U}) : G \subseteq X_1\}$ and $\exists G_0 \in \beta O(\mathfrak{U})$ where $x_1 \in G_0 \subseteq X_1$. Therefore, $\underline{R}_\beta(X_1) \subseteq X_1$. Let $x_1 \in X_1$. Then,$x_1 \in F$ by the definition of $\mathfrak{No}$ upper approximation $\forall F \in \beta C(\mathfrak{U})$. Thus, $X_1 \subseteq \overline{R}_\beta(X_1)$,

(ii) Obvious.

(iii) Assume that, $x_1 \in \underline{R}_\beta(X_1)$, $X_1 \subseteq Y_1$. Therefore $x_1 \in \underline{R}_\beta(Y_1)$ by the definition of $\mathfrak{No}$ upper approximation. Also, let $X_1 \notin \overline{R}_\beta(Y_1)$, hence $X_1 \notin \overline{R}_\beta(Y_1) = \bigcap\{F \in \beta C(\mathfrak{U}) : Y_1 \subseteq F\}$, then there exists $Y_1 \subseteq F \in \beta C(\mathfrak{U})$ and $X_1 \notin F$. This leads to $\exists F \in \beta C(\mathfrak{U})$, $X_1 \subseteq Y_1 \subseteq F$ and $X_1 \notin F$ and $X_1 \notin \overline{R}_\beta(X_1) = \bigcap\{F \in \beta C(\mathfrak{U}) : X_1 \subseteq F\}$. Hence , $X_1 \notin \overline{R}_\beta(X_1)$ and $\overline{R}_\beta(X_1) \subseteq \overline{R}_\beta(Y_1)$.

(iv) Since $X_1 \subseteq X_1 \cup Y_1$, $Y_1 \subseteq X_1 \cup Y_1$, then $\underline{R}_\beta(X_1) \subseteq \underline{R}_\beta(X_1 \cup Y_1)$,$\underline{R}_\beta(Y_1) \subseteq \underline{R}_\beta(X_1 \cup Y_1)$. Thus, $\underline{R}_\beta(X_1) \cup \underline{R}_\beta(Y_1) \subseteq \underline{R}_\beta(X_1 \cup Y_1)$. Let $x_1 \in \underline{R}_\beta(X_1 \cup Y_1)$, then $x_1 \in \bigcup\{G \in \beta O(U) : G \subseteq X_1 \cup Y_1\}$. Thus, $\exists G_0 \in \beta O(\mathfrak{U})$ where $x_1 \in G_0 \subseteq X_1 \cup Y_1$. There exist three cases:
Case (1) If $G_0 \subset X_1, X_1 \in X_1$, thus $x_1 \in \underline{R}_\beta(X_1)$.
Case (2) if $G_0 \cap X_1 = \phi$, then $G_0 \subset Y$ and $x_1 \in G_0$, so $x_1 \in \underline{R}_\beta(X_1)$.
Case (3) if $G_0 \cap X_1 \neq \phi$. where $x_1 \in G_0$ and G_0 is β-open set, therefore $x_1 \in \beta C(X_1)$, and hence $x_1 \in \underline{R}_\beta(X_1)$.
From three cases $x_1 \in \underline{R}_\beta(X_1) \cup \underline{R}_\beta(Y_1)$.

(v) Similar to (iv),

(vi) Let $x_1 \in \underline{R}_\beta(X_1^c)$. Then, $x_1 \in \bigcup\{G \in \beta O(U) : G \subseteq X_1^c\}$. So, $\exists G_0 \in \beta O(\mathfrak{U})$ such that $x_1 \in G_0 \subseteq X_1^c$. Then, there exists G_0^c such that $X_1 \subseteq G_0^c$ and $X_1 \notin G_0^c$, $G_0^c \in \beta C(\mathfrak{U})$. Hence $X_1 \notin \overline{R}_\beta(X_1)$. Thus $x_1 \in (\overline{R}_\beta(X_1))^c$ and $\underline{R}_\beta(X_1^c) = (\overline{R}_\beta(X_1))^c$. Also, we can prove that $\overline{R}_\beta(X_1^c) = (\underline{R}_\beta(X_1))^c$.

(vii) Since $\underline{R}_\beta(X_1) = \bigcup\{G \in \beta O(\mathfrak{U}) : G \subseteq X_1\}$. Therefore, $\underline{R}_\beta(\underline{R}_\beta(X_1)) = \bigcup\{\bigcup\{G \in \beta O(\mathfrak{U}) : G \subseteq X_1\}\} = \bigcup\{G \in \beta O(\mathfrak{U}) : G \subseteq X_1\} = \underline{R}_\beta(X_1)$. $\overline{R}_\beta(\overline{R}_\beta(X_1)) = \overline{R}_\beta((\underline{R}_\beta(X_1^c))^c) = (\underline{R}_\beta((\underline{R}_\beta(X_1^c))^c))^c = (\underline{R}_\beta(X_1^c))^c = (\overline{R}_\beta(X_1^c))^c = \overline{R}_\beta(X_1)$.
□

4. COVID-19 in terms of topological $\mathfrak{No}$

Fever, fatigue, and dry hack are the most well-known symptoms of COVID-19 infection. Torment and throbs, nasal blockage, migraine, conjunctivitis, sore throat, the runs, loss of taste or smell, a rash, or discoloration of the fingers or toes are some of the less common adverse effects that a few people may experience. These manifestations are typically mellow and begin gradually. Only a few people are able to be contained without mild symptoms. Symptoms may vary from one country to another and change from common to mild or strong symptoms and may become a fleeting symptom. With the occurrence of mutations in Covid-19, new symptoms appear and differ from one country to another in their severity, and other symptoms disappear. But there are symptoms such as fever, fatigue and dehydration that persist despite these mutations.

In this application, we analyze the data of a group of patients. They showed a group of different symptoms. Their data was in the following Table 1 where; hight temperature, breathing difficulty, physical strain, sore throat and lack of smell are represented by the symbols; $\mathfrak{A}_1, \mathfrak{A}_2, \mathfrak{A}_3, \mathfrak{A}_4, \mathfrak{A}_5$, respectively. 1 refers to "Yes" , 0 refers to "No",+ refers to "Positive" and $-$ refers to "Negative"

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Table 1. The side effects of COVID-19 infection.

Patients	$\mathfrak{A}_1$	$\mathfrak{A}_2$	$\mathfrak{A}_3$	$\mathfrak{A}_4$	$\mathfrak{A}_5$	*Decision*
$\mathfrak{p}_1$	1	1	1	1	1	+
$\mathfrak{p}_2$	1	1	1	1	0	+
$\mathfrak{p}_3$	1	1	1	0	1	−
$\mathfrak{p}_4$	1	1	1	0	0	−
$\mathfrak{p}_5$	1	1	0	1	1	−
$\mathfrak{p}_6$	1	1	0	1	0	−
$\mathfrak{p}_7$	1	1	0	0	1	−
$\mathfrak{p}_8$	1	1	0	0	0	−
$\mathfrak{p}_9$	1	0	1	1	1	−
$\mathfrak{p}_{10}$	1	0	1	1	0	−
$\mathfrak{p}_{11}$	1	0	1	0	1	−
$\mathfrak{p}_{12}$	1	0	1	0	0	−
$\mathfrak{p}_{13}$	1	0	0	1	1	−
$\mathfrak{p}_{14}$	1	0	0	1	0	−
$\mathfrak{p}_{15}$	1	0	0	0	1	−
$\mathfrak{p}_{16}$	1	0	0	0	0	−
$\mathfrak{p}_{17}$	0	1	1	1	1	+
$\mathfrak{p}_{18}$	0	1	1	1	0	+
$\mathfrak{p}_{19}$	0	1	1	0	1	−
$\mathfrak{p}_{20}$	0	1	1	0	0	−
$\mathfrak{p}_{21}$	0	1	0	1	1	−
$\mathfrak{p}_{22}$	0	1	0	1	0	−
$\mathfrak{p}_{23}$	0	1	0	0	1	−
$\mathfrak{p}_{24}$	0	1	0	0	0	−
$\mathfrak{p}_{25}$	0	0	1	1	1	−
$\mathfrak{p}_{26}$	0	0	1	1	0	−
$\mathfrak{p}_{27}$	0	0	1	0	1	−
$\mathfrak{p}_{15}$	1	0	0	0	1	−
$\mathfrak{p}_{28}$	0	0	1	0	0	−
$\mathfrak{p}_{29}$	0	0	0	1	1	−
$\mathfrak{p}_{30}$	0	0	0	1	0	−
$\mathfrak{p}_{31}$	0	0	0	0	1	−
$\mathfrak{p}_{32}$	0	0	0	0	0	−

Based on the information system of COVID-19 in Table 1 and the $\mathfrak{No}$ approximation structure, we will discover and predict disease-causing factors, disease detection using a new algorithm .

4.1. Algorithm of the side effects of COVID-19 infection

Step 1: Assume that $\mathfrak{U}$ is the universe of discourse, R is the set of condition attributes and C is decision attribute.
Step 2: Find Pawlak's L_{app}, U_{app} and the boundary of any set $X_1 \subseteq U$.
Step 3: Remove any attribute $A_i \in R$, take $U/R - A_i$ as a base for topology and find the set $\beta O(\mathfrak{U})$.
Step 4: Calculate $\beta - L_{app}$, $\beta - U_{app}$ and the boundary of the set X_1.
Step 5: If the boundary of X_1 in Step 2 and Step 4 are the same, then $\mathfrak{A}_i$ is superfluous attribute.
Step 6: Repeat Step 3, Step 4 and Step 5 for all condition attributes and find reduct(R).

Continued from Table 1:
Step 1: Let $\mathfrak{U} = \{\mathfrak{p}_1, \mathfrak{p}_2, \mathfrak{p}_3, \mathfrak{p}_4, \mathfrak{p}_5, \mathfrak{p}_6, \mathfrak{p}_7, \mathfrak{p}_8, \mathfrak{p}_9\}$ be the set of patients, $R = \{\mathfrak{A}_1, \mathfrak{A}_2, \mathfrak{A}_3, \mathfrak{A}_4, \mathfrak{A}_5\}$ be the condition attributes, $C = \{+, -\}$ be the condition attributes and $X_1 = \{\mathfrak{p}_1, \mathfrak{p}_2, \mathfrak{p}_{17}, \mathfrak{p}_{18}\}$ be the set of patients having + results. Then $U/R = \{\{\mathfrak{p}_1\}, \{\mathfrak{p}_2\}, \{\mathfrak{p}_3\}, \{\mathfrak{p}_4\},$ $\{\mathfrak{p}_5\}, \{\mathfrak{p}_6\}, \{\mathfrak{p}_7\}, \{\mathfrak{p}_8\}, \{\mathfrak{p}_9\}, \{\mathfrak{p}_{10}\}, \{\mathfrak{p}_{11}\}, \{\mathfrak{p}_{12}\}, \{\mathfrak{p}_{13}\}, \{\mathfrak{p}_{14}\}, \{\mathfrak{p}_{15}\}, \{\mathfrak{p}_{16}\}, \{\mathfrak{p}_{17}\}, \{\mathfrak{p}_{18}\}, \{\mathfrak{p}_{19}\}, \{\mathfrak{p}_{20}\},$ $\{\mathfrak{p}_{21}\}, \{\mathfrak{p}_{22}\}, \{\mathfrak{p}_{23}\}, \{\mathfrak{p}_{24}\}, \{\mathfrak{p}_{25}\}, \{\mathfrak{p}_{26}\}, \{\mathfrak{p}_{27}\}, \{\mathfrak{p}_{28}\}, \{\mathfrak{p}_{29}\}, \{\mathfrak{p}_{30}\}, \{\mathfrak{p}_{31}\}, \{\mathfrak{p}_{32}\}\}$.
Step 2: pawlak's L_{app} and U_{app} of X_1 is: $\underline{R}(X_1) = \{\mathfrak{p}_1, \mathfrak{p}_2, \mathfrak{p}_{17}, \mathfrak{p}_{18}\}$, $\overline{R}(X_1) = \{\mathfrak{p}_1, \mathfrak{p}_2, \mathfrak{p}_{17}, \mathfrak{p}_{18}\}$, $BN_R(X_1) = \phi$.
Step 3: **Case (i)** Remove the attribute $\mathfrak{A}_1$, then $U/R - (\mathfrak{A}_1) = \{\{\mathfrak{P}_1, \mathfrak{p}_{17}\}, \{\mathfrak{p}_2, \mathfrak{p}_{18}\}, \{\mathfrak{p}_3, \mathfrak{p}_{19}\}, \{\mathfrak{p}_4, \mathfrak{p}_{20}\},$ $\{\mathfrak{p}_5, \mathfrak{p}_{21}\}, \{\mathfrak{p}_6, \mathfrak{p}_{22}\}, \{\mathfrak{p}_7, \mathfrak{p}_{23}\}, \{\mathfrak{p}_8, \mathfrak{p}_{24}\}, \{\mathfrak{p}_9, \mathfrak{p}_{25}\}, \{\mathfrak{p}_{10}, \mathfrak{p}_{26}\}, \{\mathfrak{p}_{11}, \mathfrak{p}_{27}\}, \{\mathfrak{p}_{12}, \mathfrak{p}_{28}\},$ $\{\mathfrak{p}_{13}, \mathfrak{p}_{29}\}, \{\mathfrak{p}_{14}, \mathfrak{p}_{30}\}, \{\mathfrak{p}_{15}, \mathfrak{p}_{31}\}, \{\mathfrak{p}_{16}, \mathfrak{p}_{32}\}\}$ is a base for topology and we can deduce the set $\beta O(\mathfrak{U})$.
Step 4: The $\beta - L_{app}$, $\beta - U_{app}$ and boundary of X_1 are: $\underline{R}_\beta(X_1) = \{\mathfrak{p}_1, \mathfrak{p}_2, \mathfrak{p}_{17}, \mathfrak{p}_{18}\}$, $\overline{R}_\beta(X_1) = \{\mathfrak{p}_1, \mathfrak{p}_2, \mathfrak{p}_{17}, \mathfrak{p}_{18}\}$ and $BN_\beta(X_1) = \phi$.
Step 5: Since $BN_\beta(X_1) = \phi = BN_R(X_1) = \phi$, then $\mathfrak{A}_1$ is superfluous attribute which means it is not necessary for patients having + results.
Step 6:Case (ii) Remove the attribute $\mathfrak{A}_2$, then $U/R - (\mathfrak{A}_2) = \{\{\mathfrak{p}_1, \mathfrak{p}_9\}, \{\mathfrak{p}_2, \mathfrak{p}_{10}\}, \{\mathfrak{p}_3, \mathfrak{p}_{11}\}, \{\mathfrak{p}_6, \mathfrak{p}_{14}\},$ $\{\mathfrak{p}_7, \mathfrak{p}_{15}\}, \{\mathfrak{p}_6, \mathfrak{p}_{22}\}, \{\mathfrak{p}_7, \mathfrak{p}_{23}\}, \{\mathfrak{p}_8, \mathfrak{p}_{24}\}, \{\mathfrak{p}_9, \mathfrak{p}_{25}\}, \{\mathfrak{p}_9, \mathfrak{p}_{25}\}, \{\mathfrak{p}_{10}, \mathfrak{p}_{26}\}, \{\mathfrak{p}_{11}, \mathfrak{p}_{27}\}, \{\mathfrak{p}_4, \mathfrak{p}_{12}\}, \{\mathfrak{p}_5, \mathfrak{p}_{13}\}$ $\{\mathfrak{p}_8, \mathfrak{p}_{16}\}, \{\mathfrak{p}_{17}, \mathfrak{p}_{25}\}, \{\mathfrak{p}_{18}, \mathfrak{p}_{26}\}, \{\mathfrak{p}_{19}, \mathfrak{p}_{27}\}, \{\mathfrak{p}_{20}, \mathfrak{p}_{28}\}, \{\mathfrak{p}_{21}, \mathfrak{p}_{29}\}, \{\mathfrak{p}_{22}, \mathfrak{p}_{30}\}, \{\mathfrak{p}_{23}, \mathfrak{p}_{31}\}, \{\mathfrak{p}_{24}, \mathfrak{p}_{32}\}$.
Therefore, $\underline{R}_\beta(X_1) = \phi$, $\overline{R}_\beta(X_1) = \{\mathfrak{p}_1, \mathfrak{p}_2, \mathfrak{p}_9, \mathfrak{p}_{10}, \mathfrak{p}_{17}, \mathfrak{p}_{18}, \mathfrak{p}_{25}, \mathfrak{p}_{26}\}$ and $BN_\beta(X_1) = \{\mathfrak{p}_1, \mathfrak{p}_2, \mathfrak{p}_9, \mathfrak{p}_{10}, \mathfrak{p}_{17},$ $\mathfrak{p}_{18}, \mathfrak{p}_{25}, \mathfrak{p}_{26}\} \neq BN_R(X_1)$.
Case (iii) Remove the attribute $\mathfrak{A}_3$,then $U/R - (\mathfrak{A}_3) = \{\{\mathfrak{p}_1, \mathfrak{p}_5\}, \{\mathfrak{p}_2, \mathfrak{p}_6\}, \{\mathfrak{p}_3, \mathfrak{p}_7\}, \{\mathfrak{p}_4, \mathfrak{p}_8\},$ $\{\mathfrak{p}_9, \mathfrak{p}_{13}\}, \{\mathfrak{p}_{10}, \mathfrak{p}_{14}\}, \{\mathfrak{p}_{11}, \mathfrak{p}_{15}\}, \{\mathfrak{p}_{12}, \mathfrak{p}_{16}\}, \{\mathfrak{p}_{17}, \mathfrak{p}_{21}\}, \{\mathfrak{p}_{18}, \mathfrak{p}_{22}\}, \{\mathfrak{p}_{19}, \mathfrak{p}_{23}\}, \{\mathfrak{p}_{20}, \mathfrak{p}_{24}\}, \{\mathfrak{p}_{25}, \mathfrak{p}_{29}\},$ $\{\mathfrak{p}_{26}, \mathfrak{p}_{30}\}, \{\mathfrak{p}_{27}, \mathfrak{p}_{31}\}, \{\mathfrak{p}_{28}, \mathfrak{p}_{32}\}\}$. Hence, $\underline{R}_\beta(X_1) = \phi$, $\overline{R}_\beta(X_1) = \{\mathfrak{p}_1, \mathfrak{p}_5, \mathfrak{p}_2, \mathfrak{p}_6, \mathfrak{p}_{17}, \mathfrak{p}_{21}, \mathfrak{p}_{18}, \mathfrak{p}_{22}\}$ and $BN_\beta(X_1) = \{\mathfrak{p}_1, \mathfrak{p}_5, \mathfrak{p}_2, \mathfrak{p}_6, \mathfrak{p}_{17}, \mathfrak{p}_{21}, \mathfrak{p}_{18}, \mathfrak{p}_{22}\} \neq BN_R(X_1)$.
Case (iv) Remove the attribute $\mathfrak{A}_4$,then $U/R - (\mathfrak{A}_4) = \{\{\mathfrak{p}_1, \mathfrak{p}_3\}, \{\mathfrak{p}_2, \mathfrak{p}_4\}, \{\mathfrak{p}_5, \mathfrak{p}_7\}, \{\mathfrak{p}_6, \mathfrak{p}_8\},$ $\{\mathfrak{p}_9, \mathfrak{p}_{11}\}, \{\mathfrak{p}_{10}, \mathfrak{p}_{12}\}, \{\mathfrak{p}_{13}, \mathfrak{p}_{15}\}, \{\mathfrak{p}_{14}, \mathfrak{p}_{16}\}, \{\mathfrak{p}_{17}, \mathfrak{p}_{19}\}, \{\mathfrak{p}_{18}, \mathfrak{p}_{20}\}, \{\mathfrak{p}_{21}, \mathfrak{p}_{23}\}, \{\mathfrak{p}_{22}, \mathfrak{p}_{24}\}, \{\mathfrak{p}_{25}, \mathfrak{p}_{27}\},$ $\{\mathfrak{p}_{26}, \mathfrak{p}_{28}\}, \{\mathfrak{p}_{29}, \mathfrak{p}_{31}\}, \{\mathfrak{p}_{30}, \mathfrak{p}_{32}\}\}$. Hence, $\underline{R}_\beta(X_1) = \phi$, $\overline{R}_\beta(X_1) = \{\mathfrak{p}_1, \mathfrak{p}_3, \mathfrak{p}_2, \mathfrak{p}_4, \mathfrak{p}_{17}, \mathfrak{p}_{19}, \mathfrak{p}_{18}, \mathfrak{p}_{20}\}$ and $BN_\beta(X_1) = \{\mathfrak{p}_1, \mathfrak{p}_3, \mathfrak{p}_2, \mathfrak{p}_4, \mathfrak{p}_{17}, \mathfrak{p}_{19}, \mathfrak{p}_{18}, \mathfrak{p}_{20}\} \neq BN_R(X_1)$.
Case (v) Remove the attribute $\mathfrak{A}_5$, then $\mathfrak{U}/R - (\mathfrak{A}_5) = \{\{\mathfrak{p}_1, P_2\}, \{\mathfrak{p}_3, \mathfrak{p}_4\}, \{\mathfrak{p}_5, \mathfrak{p}_6\}, \{\mathfrak{p}_7, \mathfrak{p}_8\},$ $\{\mathfrak{p}_9, \mathfrak{p}_{10}\}, \{\mathfrak{p}_{11}, \mathfrak{p}_{12}\}, \{\mathfrak{p}_{13}, \mathfrak{p}_{14}\}, \{\mathfrak{p}_{15}, \mathfrak{p}_{16}\}, \{\mathfrak{p}_{17}, \mathfrak{p}_{18}\}, \{\mathfrak{p}_{19}, \mathfrak{p}_{20}\}, \{\mathfrak{p}_{21}, \mathfrak{p}_{22}\}, \{\mathfrak{p}_{23}, \mathfrak{p}_{24}\}, \{\mathfrak{p}_{25}, \mathfrak{p}_{26}\},$ $\{\mathfrak{p}_{27}, \mathfrak{p}_{28}\}, \{\mathfrak{p}_{29}, \mathfrak{p}_{30}\}, \{\mathfrak{p}_{31}, \mathfrak{p}_{32}\}\}$. Hence, $\underline{R}_\beta(X_1) = \{\mathfrak{p}_1, \mathfrak{p}_2, \mathfrak{p}_{17}, \mathfrak{p}_{18}\}$, $\overline{R}_\beta(X_1) = \{\mathfrak{p}_1, \mathfrak{p}_2, \mathfrak{p}_{17}, \mathfrak{p}_{18}\}$ and $BN_\beta(X_1) = \phi$.
Therefore reduct($\mathfrak{R}$) $= \{\mathfrak{A}_2, \mathfrak{A}_3, \mathfrak{A}_4\}$. Similarly, if $\mathfrak{Y}$ is the set of patients having - result, then again reduct($\mathfrak{R}$) $= \{\mathfrak{A}_2, \mathfrak{A}_3, \mathfrak{A}_4\}$.

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Theorem 1. *From the previous application, we conclude that only the symptoms that make up the reduct confirm the presence of the disease, therefore appropriate preventive measures must be taken, given a + situation*

5. Conclusion

An algorithm is developed to find the core in an information system. The counter example is discussed to find the core of the systems. The paper concluded that breathing difficulty,physical strain and sore throat which are represented by the symbols $\mathfrak{A}_2, \mathfrak{A}_3$ and $\mathfrak{A}_4$ respectively. These symptoms are closely connected to the disease (covid 19).

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