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Decision Making in an Information System Via Pawlak's Rough Approximation

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Abstract

The original rough set model was based on a special kind of topological structure whose partition resulted from an equivalence relation. We have shown that real-world problems can be dealt with using the modern topological structure induced by Pawlak's rough approximation. In this research, actual information was collected for some patients in hospitals, health centers, isolation centers and some symptoms were recorded through " the World Health Organization" website enabled us analyze their data. By establishing an information system in which data can be analyzed using rough topology in order to draw conclusion about the most important symptoms in disease confirmation.

Key words and pharases: Rough Topology; modern topology; basis; COVID-19.

1 Introduction

In the examination of the emergent coronavirus (Covid-19), characterized by its nominal mass, it is noteworthy that specialists posit the cumulative weight of all coronaviruses infecting millions globally is scarcely two grams. Despite this seemingly inconspicuous mass, the virus has exerted a more potent impact than atomic weaponry [1]. In response to the escalating informational repository on the coronavirus, contemporary scientific endeavours involve the application of sophisticated methodologies and technologies for numerical analysis. Notably, a collaborative initiative between the University of California's laboratory and the Energy Lab has yielded novel algorithms, employing mathematical programming tools and computational resources.

These advancements aim to enhance the feasibility and efficacy of the current analytical processes pertinent to the COVID-19 epidemic [1].

The concerted efforts of scientists and researchers in the field of virology worldwide are evident in their response to the Covid-19 pandemic. Since its inception in December 2019 in Wuhan, China, and subsequent global dissemination resulting in significant mortality and morbidity, the international community has mobilized its collective capabilities to develop treatments and vaccines. The emergence of a new strain of human

COVID-19 has escalated public health concerns due to its proclivity for inducing respiratory tract infections. Human-to-human transmissions, with incubation periods ranging from 2 to 10 days, facilitate the virus's dissemination through droplets, contaminated surfaces, or hands. Consequently, COVID-19 has emerged as a formidable global health threat, leading to widespread fatalities and necessitating an urgent response [2].

The gravity of the situation is underscored by the relentless progression of fatalities, prompting individuals to confront mortality in the face of this formidable pathogen. This discourse aims to contribute to the identification of symptoms paramount to the disease's dissemination. It is imperative to acknowledge the heterogeneous impact of COVID-19 on individuals, with some experiencing mild to moderate symptoms and achieving recovery without hospitalization [2].

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.

In this section, we present another topology called rough topology [3] in terms of the lower approximation (L_{app}) and upper approximation (U_{app}), the way that rough topology is reduced depends on how data is divided up into a group by information systems. Where in the categories are components of the same condition and the reduction of effects the classification, consequently, this approach is one of the finest ways to handle information systems that can be erased elements and attributes are not important to the final decision. The theory of rough topology was introduced by Lellis Thivagar and Richard [3, 4].

Utilizing approximation theories and the boundary region of a subset of the universe based on the equivalence relation (ER), the theory is resolved. Moreover, in light of the theory closed nanoscale groups, nanostructures and inward nanostrctures are recognized. Open nanoparticles allude to components of nano space, the source of nanoscience is the Greek word "Nano" [9, 10] which means predominate regarding present- day science, for example, the request for size of a billion. The assignment of the topology prompted the modern topology, which comprised of close to five components.

In 2016 Lellis Thivagar et al, regarded the ideal of topological nanoscale space though a diagram. Pawlak presented the rough set theory in the mid- 1980s. the hypothesis depended on the detect ability of items. The rough set theory provides a structured framework that equips planners with the capability to address uncertainty. In instances where an optimal outcome is indeterminable within a given knowledge base, rough sets

facilitate an approximation with respect to that information. From a clinical standpoint, the inherent value boundaries are often characterized by uncertainty
[8].

In preceding investigations, topology has been employed to examine the similarity of DNA sequences and discern mutations in genes, chromosomes, their respective loci, and altered amino acids [11, 12]. Furthermore, topology has been applied to scrutinize DNA recombination [13], leading to the formulation of a mathematical model delineating the recombination process. The utilization of the topological parameter τ in the study of DNA recombination has proven advantageous, generating multiple spatial representations. Topological principles can be leveraged to construct adaptable mathematical models within the realm of biomathematics. This project demonstrates that contemporary topology can effectively address real-world issues. The concepts of modern topology and basis have been deployed to ascertain the determinants of a recent outbreak of the virus ”COVID-19,” widely documented globally. In this investigation, the modern topological model aligns well with clinical applications, as endorsed by medical specialists.

2 Preliminaries

The way to reduce rough topology depends on dividing data through information systems into a group, categories are components of the same circumstances, categorization is impacted when they are reduced. Their reduction influences classification The reduction of categories, which are elements of the same circumstances, has an effect on classification,

So, this is one of the best ways to handle information systems that can be removed from condition and elements that not affect the decision [5, 6].

We begin with the basic concepts of modern topology that we will need in the medical application whose data are to be analyzed.

Definition 2.1. [7] Let U be a universe of discourse, and R be an *ER* on U. H = (U,R) is called an approximation structure. For a subset $X_1 \subseteq U$, the $L_{app}(X_1)$ and $U_{app}(X_1)$ are defined as:

$$L_{app}(X_1) = \{x_1 \in U : [x_1]_R \subseteq X_1\},$$

$$U_{app}(X_1) = \{x_1 \in U : [x_1]_R \cap X_1 \neq \emptyset\}, B_R(X_1) =$$

$$U_{app}(X_1) - L_{app}(X_1).$$

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Proposition 2.2. *[7] If* (U,R) *is an approximation structure. and* $X_1,Y_1 \subseteq U$*, then:*

$(i) L_{app}(X_1) \subseteq X_1 \subseteq U_{app}(X_1)$.

$(ii) L_{app}(\phi) = U_{app}(\phi) = \phi$ *and* $L_{app}(U) = U_{app}(U) = U$.

$(iii) U_{app}(X_1 \cup Y_1) = U_{app}(X_1) \cup U_{app}(Y_1)$.

$(iv) U_{app}(X_1 \cap Y_1) \subseteq U_{app}(X_1) \cap U_{app}(Y_1)$.

$(v) L_{app}(X_1 \cup Y_1) \supseteq L_{app}(X_1) \cup L_{app}(Y_1)$.

$(vi) L_{app}(X_1 \cap Y_1) = L_{app}(X_1) \cap L_{app}(Y_1)$.

(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. [4] Let U_1 be the universe, R be an *ER* on U_1 and $\tau_R(Y_1) = \{U_1,\phi,U_{app}(Y_1),L_{app}(Y_1),B_R(Y_1)\}$, is called modern topology , such that $Y_1 \subseteq U_1$ and $\tau_R(Y_1)$ fulfills the accompanying aphorisms:

(1) U_1 *and* $\phi \in \tau_R(Y_1)$,

(2) The union of the objects of any subcollection of $\tau_R(Y_1)$ is in $\tau_R(Y_1)$,

(3) The intersection of the finite elements of any subcollection $\tau_R(Y_1)$ is in $\tau_R(Y_1)$.

Proposition 2.4. *[4] If* $\tau_R(Y)$ *is a modern topology on* U_1 *with respect to* Y*, then the family* $\beta(\tau_R(Y)) = \{U,L_{app}(Y),B_R(Y)\}$ *is a basis for* $\tau_R(Y)$.

Definition 2.5. [3] Let U_1 be the universe, R be an *ER* on U_1 and $\tau_R(Y)$ be the modern topology on U_1 and $\beta(\tau_R(Y))$ a basis for $\tau_R(Y)$. A subset Q of S (the set of attributes) is named *core* of *R* if $\beta(\tau_R(Y)) \neq \beta(\tau_{R-(Q_i)}(Y)), \forall Q_i \in S$. A core of R, which is a subset of attributes, such that none of its components can be expelled without impacting the characterisation intensity of attributes.

3 Medical Application Via Modern Topology

In many complex or data-dense systems, we need effective application to convert them into information systems so that we can model and choose the best methods for analyzing this data and obtain quick results and shorten duplicate and unwanted data. in this part, we will analyze a set of patient data to obtain the best way to diagnose the disease using modern topology.

3.1 The COVID-19 Viruses

The coronaviruses are a large group of different pathogens that can make people and other animals sick. It has been discovered that different coronaviruses are responsible for a range of respiratory disorders in humans, beginning with the most common virus and progressing to the most serious conditions, for example, Middle East Respiratory Syndrome MERS and SARS, the newfound Coronaviruses (COVID-19) causes sickness, the COVID-19 sickness is an irresistible infection brought about by the last identified infection from the Coronaviruses. Before this new infection's flare-up in Wuhan, China, in December 2019, there was no knowledge of its existence or illness. COVID-19 is a pandemic that is currently affecting several countries around the world
[2].

3.2 COVID-19 Infection's Side Effects

The three most common symptoms of COVID-19 infection are fever, exhaustion, and a dry cough. Torment and throbbing, nasal blockage, migraine, conjunctivitis, sore throat, the runs, loss of taste or smell, a rash or staining of the fingers or toes are some of the less common side effects that some patients may experience. These manifestations are generally mellow and incrementally at first.
Some infected individuals don't have any noticeable adverse effects [2]. A great many people (about 80 %) recoup from the malady without the requirement for extraordinary treatment. Be that as it may, this side effects are progressively serious for around one out of each five individuals with COVID-19 illness who experiences trouble relaxing.

People who are older and those who have additional medical conditions, such as diabetes, cancer, heart disease, or hypertension, are at an increased risk of developing major problems. Any person of any age should get medical attention right away if they acquire a fever and hack that is accompanied by wheezing, difficulty breathing, weight loss, chest pain, or a loss of speech or development.
It is recommended that the patient contact the doctor or medical services office as soon as possible so that the patient can be directed to the appropriate facility.

3.3 Representation of The Data System for Symptoms in Patients

In this study, we aim to conduct an analysis of the patient data set denoted as Z_i, characterized by the manifestation of diverse symptoms. The dataset is presented in Table 1, employing the information system associated with COVID-19 and modern topology. Our objective is to discern and predict factors contributing to the onset of the disease, employing a novel algorithm rooted in modern topology for disease detection. The symbols used in the study represent the following symptoms: ”High temperature, Breathing difficulty, Physical strain, Sore throat, and Lack of smell or taste.” Q_1, Q_2, Q_3, Q_4 and Q_5, respectively. Suppose that :” *yes* ≡ 1, *No* ≡ 0, *Positive* ≡ + and *Negative* ≡−.

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

Z_i	Q_1	Q_2	Q_3	Q_4	Q_5	Decision
Z_1	1	1	1	1	1	+
Z_2	1	1	1	1	0	+
Z_3	1	1	1	0	1	-
Z_4	1	1	1	0	0	-
Z_5	1	1	0	1	1	-
Z_6	1	1	0	1	0	-
Z_7	1	1	0	0	1	-
Z_8	1	1	0	0	0	-
Z_9	1	0	1	1	1	-
Z_{10}	1	0	1	1	0	-
Z_{11}	1	0	1	0	1	-
Z_{12}	1	0	1	0	0	-
Z_{13}	1	0	0	1	1	-
Z_{14}	1	0	0	1	0	-
Z_{15}	1	0	0	0	1	-

Z_{16}	1	0	0	0	0	-
Z_{17}	0	1	1	1	1	+
Z_{18}	0	1	1	1	0	+
Z_{19}	0	1	1	0	1	-
Z_{20}	0	1	1	0	0	-
Z_{21}	0	1	0	1	1	-
Z_{22}	0	1	0	1	0	-
Z_{23}	0	1	0	0	1	-
Z_{24}	0	1	0	0	0	-
Z_{25}	0	0	1	1	1	-
Z_{26}	0	0	1	1	0	-
Z_{27}	0	0	1	0	1	-
Z_{28}	0	0	1	0	0	-
Z_{29}	0	0	0	1	1	-
Z_{30}	0	0	0	1	0	-
Z_{31}	0	0	0	0	1	-
Z_{32}	0	0	0	0	0	-

Algorithm of the modern topology to detect the effects of COVID-19 infection

Step 1: Let U_1 be the universe set, S be a set of attributes, D the decision of attributes ,columns are labeled by attributes and rows are elements.

Step 2 : Find the lower L_{app}, the upper approximation U_{app} and the boundary B_R.

Step 3: Delete an attributes Q_i for S, where $Q_i \subseteq S$, calculate L_{app}, U_{app} and B_R.

Step 4: Form the modern topology $(\tau_{R-(Q_i)}(Y))$ on U_1 and its basis $\beta(\tau_{R-(Q_i)}(Y))$.

Step 5: Renew **Step 3, 4 for all attributes in S .**

Step 6: The resulting attributes in S which $\beta(\tau_R(Y)) /= \beta(\tau_{R-(Q_i)}(Y))$ generate the CORE

Start implementing steps.

Consider U_1 = {Z_1, Z_2,Z_3, Z_4 ,Z_5,Z_6, Z_7,Z_8, Z_9 ,Z_{10}, Z_{11}, Z_{12}, Z_{13},Z_{14}, Z_{15}, Z_{16}, Z_{17},Z_{18}, Z_{19}, Z_{20}, Z_{21},Z_{22}, Z_{23}, Z_{24}, Z_{25},Z_{26}, Z_{27}, Z_{28}, Z_{29},Z_{30}, Z_{31}, Z_{32}}, the set of patients, let S = {Q_1, Q_2, Q_3, Q_4, Q_5} be the set of attributes. For Table 1, one can deduce the knowledge base as follows.

U_1/R = {{Z_1}, {Z_2},{Z_3}, {Z_4} ,{Z_5},{Z_6}, {Z_7},{Z_8}, {Z_9} ,{Z_{10}}, {Z_{11}}, {Z_{12}}, {Z_{13}},{Z_{14}}, {Z_{15}}, {Z_{16}}, {Z_{17}},{Z_{18}}, {Z_{19}}, {Z_{20}}, {Z_{21}},{Z_{22}}, {Z_{23}}, {Z_{24}}, {Z_{25}},{Z_{26}}, {Z_{27}}, {Z_{28}}, {Z_{29}},{Z_{30}}, {Z_{31}}, {Z_{32}}}

Case1:

Let Y = {Z_1, Z_2 ,Z_{17}, Z_{18}}, be the set of patients having positive results. Then

$L_{app}(Y)$ = {Z_1, Z_2 ,Z_{17}, Z_{18}}, and

$U_{app}(Y)$ = {Z_1, Z_2 ,Z_{17}, Z_{18}}.

Therefore $B_R(Y) = \phi$.

The modern topology is $\tau_R(Y)$ = {U_1,ϕ,{Z_1, Z_2 ,Z_{17}, Z_{18}}}, and its basis $\beta(\tau_R(Y))$ = {U_1,ϕ,{Z_1, Z_2 ,Z_{17}, Z_{18}}}.

Step 1: If the attribute Q_1 is removed from Table 1 then:

$U_1/(R-\{Q_1\})$ = {{Z_1,Z_{17}}, {Z_2,Z_{18}},{Z_3,Z_{19}}, {Z_4,Z_{20}} ,{Z_5,Z_{21}},{Z_6,Z_{22}}, {Z_7,Z_{23}},{Z_8,Z_{24}}, {Z_9,Z_{25}} ,{Z_{10},Z_{26}}, {Z_{11},Z_{27}}, {Z_{12},Z_{28}}, {Z_{13},Z_{29}},{Z_{14},Z_{30}}, {Z_{15},Z_{31}}, {Z_{16},Z_{32}}}, one can deduce that.

$L_{app}(Y-\{Z_1\})$ = {Z_1, Z_2 ,Z_{17}, Z_{18}}, and $U_{app}(Y-\{Z_1\})$ = {Z_1, Z_2 ,Z_{17}, Z_{18}}.

Therefore $B_R(Y-\{Q_1\}) = \phi$.

The modern topology is $\tau_{R-\{Q_1\}}(Y)$ = {U_1,ϕ,{Z_1, Z_2 ,Z_{17}, Z_{18}}}=$\tau_R(Y)$, and its basis $\beta(\tau_{R-\{Q_1\}}(Y))$ = {U_1,ϕ,{Z_1, Z_2 ,Z_{17}, Z_{18}}}=$\beta(\tau_R(Y))$.

Thus $\{Q_1\} \notin CORE(COVID-19)$.

Step 2: If the attribute Q_2 is removed then:

$U_1/(R-\{Q_2\})$ = {{Z_1,Z_9}, {Z_2,Z_{10}},{Z_3,Z_{11}}, {Z_4,Z_{12}} ,{Z_5,Z_{13}},{Z_6,Z_{14}}, {Z_7,Z_{15}},{Z_8,Z_{16}}, {Z_{17},Z_{25}} ,{Z_{18},Z_{26}}, {Z_{19},Z_{27}}, {Z_{20},Z_{28}}, {Z_{21},Z_{29}},{Z_{22},Z_{30}}, {Z_{23},Z_{31}}, {Z_{24},Z_{32}}}, one can deduce that.

$L_{app}(Y-\{Q_2\}) = \phi$, and

$U_{app}(Y-\{Q_2\})$ = {Z_1, Z_2 ,Z_9, Z_{10} ,Z_{17}, Z_{18}, Z_{25}, Z_{26}}.

Therefore $B_R(Y-\{Z_2\})$ = {Z_1, Z_2 ,Z_9, Z_{10} ,Z_{17}, Z_{18}, Z_{25}, Z_{26}}.

The modern topology is $\tau_{R-\{Q_2\}}(Y)$ = {U_1,ϕ,{Z_1, Z_2 ,Z_9, Z_{10} ,Z_{17}, Z_{18}, Z_{25}, Z_{26}}} $\neq \tau_R(Y)$, and its basis $\beta(\tau_{R-\{Q_2\}}(Y))$ = {U_1,ϕ,{Z_1, Z_2 ,Z_9, Z_{10} ,Z_{17}, Z_{18}, Z_{25}, Z_{26}}} $\neq \beta(\tau_R(Y))$.

Thus $\{Q_2\} \in CORE(COVID-19)$.

Step 3: If the attribute Q_3 is removed then:

$U_1/(R-\{Q_3\}) = \{\{Z_1,Z_5\}, \{Z_2,Z_6\},\{Z_3,Z_7\}, \{Z_4,Z_8\}, \{Z_9,Z_{13}\},\{Z_{10},Z_{14}\}, \{Z_{11},Z_{15}\},\{Z_{12},Z_{16}\},$

$\{Z_{17},Z_{21}\}, \{Z_{18},Z_{22}\},\{Z_{19},Z_{23}\}, \{Z_{20},Z_{24}\}, \{Z_{25},Z_{29}\}\{Z_{26},Z_{30}\}, \{Z_{27},Z_{31}\}, \{Z_{28},Z_{32}\}\}$, one can deduce that.

$L_{app}(Y-\{Q_3\}) = \phi$, and

$U_{app}(Y-\{Q_3\}) = \{Z_1, Z_2, Z_5, Z_6, Z_{17}, Z_{18}, Z_{21}, Z_{22}\}$.

Therefore $B_R(Y-\{Q_3\}) = \{Z_1, Z_2, Z_5, Z_6, Z_{17}, Z_{18}, Z_{21}, Z_{22}\}$.

The modern topology is $\tau_{R-\{Q_3\}}(Y) = \{U_1,\phi,\{Z_1, Z_2, Z_5, Z_6, Z_{17}, Z_{18}, Z_{21}, Z_{22}\}\} \neq \tau_R(Y)$, and its basis $\beta(\tau_{R-\{Q_3\}}(Y)) = \{U_1,\phi,\{Z_1, Z_2, Z_5, Z_6, Z_{17}, Z_{18}, Z_{21}, Z_{22}\}\} \neq \beta(\tau_R(Y))$.

Thus $\{Q_3\} \in CORE(COVID-19)$.

Step 4: If the attribute Q_4 is removed then:

$U_1/(R-\{Q_4\}) = \{\{Z_1,Z_3\}, \{Z_2,Z_4\},\{Z_5,Z_7\}, \{Z_6,Z_8\}, \{Z_9,Z_{11}\},\{Z_{10},Z_{12}\}, \{Z_{13},Z_{15}\},\{Z_{14},Z_{16}\},$

$\{Z_{17},Z_{19}\}, \{Z_{18},Z_{20}\}, \{Z_{21},Z_{23}\}, \{Z_{22},Z_{24}\}, \{Z_{25},Z_{27}\},\{Z_{26},Z_{28}\}, \{Z_{29},Z_{31}\}, \{Z_{30},Z_{32}\}\}$.

So, the pawlak approximation.

$L_{app}(Y-\{Q_4\}) = \phi$, and

$U_{app}(Y-\{Q_4\}) = \{Z_1, Z_2, Z_3, Z_4, Z_{17}, Z_{18}, Z_{19}, Z_{20}\}$.

Then $B_R(Y-\{Q_4\}) = \{Z_1, Z_2, Z_3, Z_4, Z_{17}, Z_{18}, Z_{19}, Z_{20}\}$.

The modern topology is $\tau_{R-\{Q_3\}}(Y) = \{U_1,\phi,\{Z_1, Z_2, Z_3, Z_4, Z_{17}, Z_{18}, Z_{19}, Z_{20}\}\} \neq \tau_R(Y)$, and its basis $\beta(\tau_{R-\{Q_4\}}(Y)) = \{U_1,\phi,\{Z_1, Z_2, Z_3, Z_4, Z_{17}, Z_{18}, Z_{19}, Z_{20}\}\} \neq \beta(\tau_R(Y))$.

Thus $\{Q_4\} \in CORE(COVID-19)$.

Step 5: If the attribute Q_5 is removed then:

$U_1/(R-\{Q_5\}) = \{\{Z_1,Z_2\}, \{Z_3,Z_4\},\{Z_5,Z_6\}, \{Z_7,Z_8\}, \{Z_9,Z_{10}\},\{Z_{11},Z_{12}\}, \{Z_{13},Z_{14}\},\{Z_{15},Z_{16}\},$

$\{Z_{17},Z_{18}\}, \{Z_{19},Z_{20}\}, \{Z_{21},Z_{22}\}, \{Z_{23},Z_{24}\}, \{Z_{25},Z_{26}\},\{Z_{26},Z_{28}\}, \{Z_{29},Z_{30}\}, \{Z_{31},Z_{32}\}\}$.

Therefor, $L_{app}(Y-\{Q_5\}) = \{Z_1, Z_2 Z_{17}, Z_{18}\}$, and

$U_{app}(Y-\{Q_5\}) = \{\{Z_1, Z_2 Z_{17}, Z_{18}\}$.

Hence, $B_R(Y-\{Q_5\}) = \phi$.

The modern topology is $\tau_{R-\{Q_5\}}(Y) = \{U_1,\phi,\{Z_1, Z_2 Z_{17}, Z_{18}\}\} = \tau_R(Y)$, and its basis $\beta(\tau_{R-\{Q_5\}}(Y)) = \{U_1,\phi,\{Z_1, Z_2 Z_{17}, Z_{18}\}\} = \beta(\tau_R(Y))$.

Thus $\{Q_5\} \notin CORE(COVID-19)$.

From the above results, we have : The Core (R)=$\{Q_2,Q_3,Q_4\}$.

Case 2: Similarly, if *Y* is taken as the set of patients having negative results, then again:
The Core (R)={Q_2,Q_3,Q_4}

Observation

From both cases, we conclude that breathing difficulty, physical strain, and sore throat are the key attributes necessary to decide whether a patient has a coronavirus or not.

4 Conclusions and future work

Form the previous application, we conclude that only the symptoms that make up the nucleus confirm the presence of the disease, so appropriate preventive measures must be taken, with no contact with anyone, and the patient is isolated and given does of medicine appropriate to his degree of infection as soon as possible.

An algorithm is developed to find the CORE is an information system. The counterexample is discussed to find the CORE of the system. The paper concludes that breathing difficulty, physical strain, sore throat and lack of smell taste are the key symptoms which are closely connected to the disease Coronavirus.

conflictsofinterest

The authors declare no conflict of interest.

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