IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG

An International Open Access, Peer-reviewed, Refereed Journal

Application of Hypersoft sets in Covid-19 Decision Making Model

[1]V. Inthumathi, [2]M. Amsaveni, [3]M. Arun vignesh

[1]Associate Professor, [2]Research Scholar, [3]PG student
PG and Research Department of Mathematics,
Nallamuthu Gounder Mahalingam College, Pollachi, India.
E-mail : [1]inthumathi65@gmail.com
[2]amsavenim2000@gmail.com
[3]arun007vignesh@gmail.com

Abstract : The idea of hypersoft sets is a newly emerging technique in dealing with problems in the real world. In this paper we propose two algorithms based on the hypersoft sets to obtain optimal decisions in decision making. The efficiency of the algorithms proposed is demonstrated by applying them to the current covid-19 scenario. This concept is applied in the case of finding infected patients and purchasing hand sanitizers during covid-19 pandemic spread.

***IndexTerms* – Soft set, Hypersoft set, Decision making.**

1. INTRODUCTION

The process of selecting the best from the list of alternatives available for selection is called decision making. Sometimes predefined parameters are not sufficient to take accurate decisions in solving general or real time problems, hence there may be provisions to add more parameters to the existing set that may comes either as a new or generated from processing of existing ones.

In 1999, Molodtsov[5] developed the concept of a soft set to handle difficult problems in Economics, Engineering and in Environment, where no mathematical methods could effectively deal with the many types of uncertainty.

Maji et al.[2,3,4] developed various operations for the soft set theory and conducted a more detailed theoretical analysis of soft set theory. In 2005 Chen D[1] proposed a reasonable definition of parameterized reduction of soft sets and improved the application of a soft set in a decision making problem. In 2016, Wei et al.[10] developed a new approach for selecting a product using fuzzy decision making.

In 2018, Smarandache[8] expanded the notion of a soft set to a hypersoft set by substituting the function with a multi-argument function described in the cartesian product with a different set of parameters. This concept is more adaptable than the soft set and more useful when it comes to decision making. Recently Nivetha martin et al.[7] have applied extended plithogenic hypersoft sets with dual dominant attributes in Covid-19 decision making.

The proposed decision making model is validated with the data of the present COVID -19 pandemic situations. The objective of the model is to rank the patients being identified as symptotic and affected using Decision making system.

Based on the works highlighted in the introduction this paper is organized as follows : Chapter 2 contains basic definitions related to hypersoft sets. In Chapter 3 we have applied hyper soft sets in decision making to identify the Covid-19 patients. In Chapter 4 we have applied hyper soft sets in decision making to select the best Hand sanitizer.

2. PRELIMINARIES

2.1 Soft Set [5]:

Let U be an initial universal set and E be the set of parameters. Let $P(U)$ denote the power set of U and let $A \subseteq E$. A pair (F,A) is called the soft set over U, where the mapping given by $F : A \to P(U)$. The collection of soft sets (F, A) over a universe U and the parameter set A is a family of soft sets denoted by $SS(U)_A$

Example [9]:

A soft set (F, E) describes the attractiveness of the bikes in which Mr. X is going to buy U = $\{b_1, b_2, b_3, b_4\}$ is the set of bikes under consideration. E is the set of parameters.

E = (e_1 = stylish, e_2 = heavy duty, e_3 = light, e_4 = steel body, e_5 = cheap, e_6 = good mileage, e_7 = easily started, e_8 = long driven, e_9 = costly, e_{10} = fibre body).

The soft sets can be defined as

$(F, e_1)=\{b_1, b_3, b_4\}$
$(F, e_2) = \{b_3, b_4\}$
$(F, e_3) = \{b_1\}$
$(F, e_4) = \{b_3\}$

(F, e_5) = {b_4 }
(F, e_6) = {b_1, b_2, b_4 }
(F, e_7) = {b_1, b_2, b_3, b_4 }
(F, e_8) = {b_2, b_3, b_4 }
(F, e_9) = {b_1 }

2.2 Hyper Soft Sets [6]:

Let U be a universe of discourse, *P(U)* the power set of U and $E_1, E_2, \ldots, E_n$ the pairwise disjoint sets of parameters, Let A_i be the nonempty subset of E_i for each i = 1,2,..., n. The Hypersoft set can be identified by the pair (F, $A_1 \times A_2 \times \ldots \times A_n$)
where,

$$F : A_1 \times A_2 \times \ldots \times A_n \rightarrow P(U)$$

Example [9]:

Let U = {x_1, x_2, x_3, x_4} be the collection of citizens from different countries and a set M = {x_1, x_3} ∈ U. Let the attributes be: a_1 = size, a_2 = colour, a_3 = gender, a_4 = nationality. Their attributes values respectively:
size = A_1 = {small, medium, tall},
colour = A_2 = {white, yellow, red, black},
gender = A_3 = {male, female},
nationality = A_4 = {American, French, Spanish, Italian, Chinese}.
Let the function be F: $A_1 \times A_2 \times A_3 \times A_4 \rightarrow P(U)$.
The hypersoft set can be defined as F({tall, white, female, Italian}) = {x_1, x_3}.

3. DECISION MAKING MODEL : FINDING AN INFECTED PATIENT

3.1 ANALYSIS

Coronavirus (COVID-19), the new name for the disease being caused by the recent Coronavirus, SARS-CoV-2 is all over the news. It is getting difficult to find the infected patient among the set of individuals. Although there are methods available to find the infected person by soft set decision making model, the results are more accurate in Hyper soft decision making model. Since the parameters are used in detail to find the infected patient.

3.2 DATA SET USED

Let $U = \{P_1, P_2, P_3, P_4, P_5, P_6, P_7\}$ be the set of patients

Let the attributes be e_1 = Fever, e_2 = Cold, e_3 = Breathing. Their attribute values are
A_1 = {3-5 days, 1-2 days, no fever} = {a_1, a_2, a_3}
A_2 = {5-7 days, 3-4 days, no cold} = {a_4, a_5, a_6}
A_3 = {Shortness of breath, Normal} = {a_7, a_8}
The Hyper soft set can be written as

$$\{F, A_1 \times A_2 \times A_3\} = \{\{(a_1, a_4, a_8)(P_1, P_2, P_5)\}, \{(a_2, a_5, a_8)(P_3, P_4, P_5, P_6)\}, \{(a_1, a_5, a_8)(P_2, P_3, P_5, P_6)\}, \{(a_3, a_6, a_7)(P_3, P_4, P_5, P_6, P_7)\}\}$$

we can represent this hypersoft set (F, $A_1 \times A_2 \times A_3$) in a tabular form as shown below. This style of representation will be useful for storing a hypersoft set in a computer memory. If $P_i \in F(a)$ then $P_{ij} = 1$ otherwise $P_{ij} = 0$ where P_{ij} be the entries in table
and a = (a_i, a_j, a_k)

Table-1

U \ (a_i, a_j, a_k)	(a_1, a_4, a_8)	(a_2, a_5, a_8)	(a_1, a_5, a_8)	(a_3, a_6, a_7)
P_1	1	0	0	0
P_2	1	0	1	0
P_3	0	1	1	1
P_4	0	1	0	1
P_5	1	1	1	1
P_6	0	1	1	1
P_7	0	0	0	1

3.3 REDUCT TABLE OF HYPERSOFT SET

Consider the hypersoft set $(F, E_1 \times E_2 \times E_3)$. Clearly for any $A_1 \times A_2 \times A_3 \subseteq E_1 \times E_2 \times E_3$, $(F, A_1 \times A_2 \times A_3)$ is a hypersoft subset of $(F, E_1 \times E_2 \times E_3)$. We will now define a reduct hypersoft set of the hypersoft set $(F, A_1 \times A_2 \times A_3)$.
Consider the tabular representation of the hypersoft set $(F, A_1 \times A_2 \times A_3)$. If $B_1 \times B_2 \times B_3$ is a reduction of $A_1 \times A_2 \times A_3$ then the hypersoft set $(F, B_1 \times B_2 \times B_3)$ is called the reduct hypersoft set of the hypersoft set $(F, A_1 \times A_2 \times A_3)$. Intuitively a reduct hypersoft set $(F, B_1 \times B_2 \times B_3)$ of the hypersoft set $(F, A_1 \times A_2 \times A_3)$ is essential part which suffices to describe all basic approximate descriptions of the hypersoft set $(F, A_1 \times A_2 \times A_3)$.

3.4 CHOICE VALUE OF THE PATIENT P_i

The Choice value of the patient $P_i \in U_i$ is given by

$$C_i = \sum_{i,j=1}^{n} P_{ij}$$

where, P_{ij} are the entries in the table of the reduct hypersoft set.

3.5 ALGORITHM FOR FINDING INFECTED PATIENT

The following algorithm may be followed by the Doctor to find the Patients according to their symptoms.

- Input the hypersoft set $(F, E_1 \times E_2 \times E_3)$
- Input the set $A_1 \times A_2 \times A_3$ of choice parameters of the Doctor
- Find all reduct hypersoft sets of $(F, A_1 \times A_2 \times A_3)$
- Choose one reduct hypersoft set say $(F, B_1 \times B_2 \times B_3)$ of $(F, A_1 \times A_2 \times A_3)$
- Find k, for which $C_k = \max P_i$

Then C_k is the optimal choice object. If k has more than one value, then any one of them could be chosen by the Doctor by using the options. Now we use the above algorithm to solve our original problem. Clearly from table we see that $B_1 \times B_2 \times B_3 = \{(a_1, a_4, a_8), (a_2, a_5, a_8), (a_1, a_5, a_8)\}$ is the reduct of $A_1 \times A_2 \times A_3 = \{(a_1, a_4, a_8), (a_2, a_5, a_8), (a_1, a_5, a_8), (a_3, a_6, a_7)\}$
In corresponding to the choice values the reduct hyper soft set can be represented as in Table-2

Table-2

U / (a_i, a_j, a_k)	(a_1, a_4, a_8)	(a_2, a_5, a_8)	(a_1, a_5, a_8)	Choice value $C_i = \sum P_{ij}$
P_1	1	0	0	1
P_2	1	0	1	2
P_3	0	1	1	2
P_4	0	1	0	1
P_5	1	1	1	3
P_6	0	1	1	2
P_7	0	0	0	0

Here $\max C_i = P_5$
Decision : Doctor finds P_5 is infective
The doctor likes to impose weights on his choice parameters, that is corresponding to each elements in A_1, A_2, A_3 there is a weight $w_i \in [0,1]$.

3.6 WEIGHTED TABLE OF HYPERSOFT SET

We define the weighted table of the reduct hypersoft set $(F, B_1 \times B_2 \times B_3)$ will have entries $d_{ij} = P_{ij} \times W_j$ instead of 0 and 1 only, where P_{ij} are entries in the table of the reduct hypersoft set of $(F, B_1 \times B_2 \times B_3)$

3.7 WEIGHTED CHOICE VALUE OF THE PATIENT

The weighted choice value of the patient $P_i \in U$ is Wc_i given by

$$Wc_i = \sum d_{ij} \quad \text{where } d_{ij} = P_{ij} \times W_j$$

Imposing weights on his choice parameters, The doctor could use the following revised algorithm for arriving at his final decision.

3.8 REVISED ALGORITHM FOR FINDING INFECTED PATIENTS

The following revised algorithm for finding the infected patient is

- Input the Hyper soft set $(F, E_1 \times E_2 \times E_3)$
- Input the set $A_1 \times A_2 \times A_3$ of the choice parameters of the Doctor which is subset of $E_1 \times E_2 \times E_3$
- Find all the reduct hyper soft sets of $(F, A_1 \times A_2 \times A_3)$
- Choose one reduced hypersoft set say $(F, B_1 \times B_2 \times B_3)$ of $(F, A_1 \times A_2 \times A_3)$
- Find weighted table of hypersoft set $(F, B_1 \times B_2 \times B_3)$ according to the weights decided by the doctor
- Find k, for which $Wc_k = \max Wc_i$

Then P_k is the optimal choice object. If k has more than one value, then any one of them could be chosen by the doctor using his option. Let us solve now the original problem using the weighted algorithm. Suppose that the doctor assigns the following weights for the parameters of A_1, A_2 and A_3 as follows.
For the parameter "3-5 days" put $w_1 = 0.2$
For the parameter "1-2 days" put $w_2 = 0.3$
For the parameter "no fever" put $w_3 = 0.0$
For the parameter "5-7 days" put $w_4 = 0.7$
For the parameter "3-4 days" put $w_5 = 0.1$
For the parameter "no cold" put $w_6 = 0.4$
For the parameter "shortness of breath" put $w_7 = 0.6$
For the parameter "normal" put $w_8 = 0.1$
Using these weights the reduct hypersoft set can be tabulated as in Table-3

Table-3

U / W	$W_1 = w_1 + w_4 + w_8$ $W_1 = 1.3$	$W_2 = w_2 + w_5 + w_8$ $W_2 = 0.5$	$W_3 = w_1 + w_5 + w_8$ $W_3 = 0.4$	Weighted Choice value Wc_i
P_1	1.3	0	0	1.3
P_2	1.3	0	0.4	1.7
P_3	0	0.5	0.4	0.9
P_4	0	0.5	0	0.5
P_5	1.3	0.5	0.4	2.2
P_6	0	0.5	0.4	0.9
P_7	0	0	0	0

From Table, it is clear that the Doctor finds that P_5 is infected according to his choice parameters in $A_1 \times A_2 \times A_3$.

4. DECISION MAKING MODEL : FINDING THE BEST SANITIZER

4.1 ANALYSIS

A lot of information is being presented about how help to prevent Coronavirus (COVID-19) from affecting you and your family. Perhaps the most important thing to know is that medical experts agree on this: One of the best ways to stay healthy is to wash your hands with soap and water. But if those aren't available, hand sanitizer may help rid your hands of unwanted germs. Now the problem for any individual or for the government of any state is which brand they need to purchase. So in this case we can apply hypersoft sets to the present problem to make correct decision.

4.2 DATA SET USED

Let $U = \{H_1, H_2, H_3, H_4, H_5, H_6, H_7\}$ be the set of Hand sanitizers. Let the attributes be $a_1 =$ Alcohol content, $a_2 =$ Flavour, $a_3 =$ Cost.
Their attribute values are
$A_1 = \{$ 71 - 75 %, 76 - 80 %, 81 – 90 % $\} = \{e_1, e_2, e_3\}$
$A_2 = \{$ Aloe vera, Neem, Citrus $\} = \{e_4, e_5, e_6\}$
$A_3 = \{$ Cheap, Costly $\} = \{ e_7, e_8\}$
The Hyper soft set can be written as

$$\{F, A_1 \times A_2 \times A_3\} = \{\{ (e_2, e_4, e_7)(H_1, H_2, H_4, H_5)\} \{(e_2, e_5, e_8)(H_2, H_3, H_4, H_6)\} \{(e_1, e_5, e_8)(H_1, H_2, H_3, H_7)\{(e_3, e_6, e_7)(H_1, H_2, H_4, H_6, H_7)\}\}$$

we can represent this hypersoft set $(F, A_1 \times A_2 \times A_3)$ in a tabular form as shown below. This style of representation will be useful for storing a hypersoft set in a computer memory. If $P_i \in F(a)$ then $H_{ij} = 1$ otherwise $H_{ij} = 0$ where H_{ij} be the entries in Table-4 and $a = (e_i, e_j, e_k)$

Table-4

U \ (e_i, e_j, e_k)	(e_2, e_4, e_7)	(e_2, e_5, e_8)	(e_1, e_5, e_8)	(e_3, e_6, e_7)
H_1	1	0	1	1
H_2	1	1	1	1
H_3	0	1	1	0
H_4	1	1	0	1
H_5	1	0	0	0
H_6	0	1	0	1
H_7	0	0	0	1

4.3 REDUCT TABLE OF HYPERSOFT SET

Consider the hypersoft set $(F, E_1 \times E_2 \times E_3)$. Clearly for any $A_1 \times A_2 \times A_3 \subseteq E_1 \times E_2 \times E_3$, $(F, A_1 \times A_2 \times A_3)$ is a hypersoft subset of $(F, E_1 \times E_2 \times E_3)$. We will now define a reduct hypersoft set of the hypersoft set $(F, A_1 \times A_2 \times A_3)$.
Consider the tabular representation of the hypersoft set $(F, A_1 \times A_2 \times A_3)$. If $B_1 \times B_2 \times B_3$ is a reduction of $A_1 \times A_2 \times A_3$ then the hypersoft set $(F, B_1 \times B_2 \times B_3)$ is called the reduct hypersoft set of the hypersoft set $(F, A_1 \times A_2 \times A_3)$. Intuitively a reduct hypersoft set $(F, B_1 \times B_2 \times B_3)$ of the hypersoft set $(F, A_1 \times A_2 \times A_3)$ is essential part which suffices to describe all basic approximate descriptions of the hypersoft set $(F, A_1 \times A_2 \times A_3)$.

4.4 CHOICE VALUE OF THE SANITIZER H_i

The Choice value of a Sanitizer $H_i \in U_i$ is given by

$$C_i = \sum_{i,j=1}^{n} H_{ij}$$

where, H_{ij} are the entries in the table of the reduct hypersoft set.

4.5 ALGORITHM FOR FINDING A BEST SANITIZER

The following algorithm may be followed by the Customer to find the best Sanitizer from the different brands.

- Input the hypersoft set $(F, E_1 \times E_2 \times E_3)$
- Input the set $A_1 \times A_2 \times A_3$ of choice parameters of the Customer
- Find all reduct hypersoft sets of $(F, A_1 \times A_2 \times A_3)$
- Choose one reduct hypersoft set say $(F, B_1 \times B_2 \times B_3)$ of $(F, A_1 \times A_2 \times A_3)$
- Find k, for which $C_k = \max H_i$

Then C_k is the optimal choice object. If k has more than one value, then any one of them could be chosen by the customer by using the options. Now we use the above algorithm to solve our original problem. Clearly from table we see that $B_1 \times B_2 \times B_3 = \{(e_2, e_4, e_7), (e_2, e_5, e_8), (e_1, e_5, e_8)\}$ is the reduct of $A_1 \times A_2 \times A_3 = \{(e_2, e_4, e_7), (e_2, e_5, e_8), (e_1, e_5, e_8), (e_3, e_6, e_7)\}$.
In corresponding to the choice values the reduct hyper soft set can be represented as in Table-5

Table-5

U \ (e_i, e_j, e_k)	(e_2, e_4, e_7)	(e_2, e_5, e_8)	(e_1, e_5, e_8)	**Choice value** $C_i = \sum H_{ij}$
H_1	1	0	1	2
H_2	1	1	1	3
H_3	0	1	1	2
H_4	1	1	0	2
H_5	1	0	0	1
H_6	0	1	0	1
H_7	0	0	0	0

Here $\max C_i = H_2$

Decision : The customer finds H_2 is preferable

The Customer likes to impose weights on his choice parameters, that is corresponding to each elements in A_1, A_2, A_3 there is a weight $w_i \in [0,1]$.

4.6 WEIGHTED TABLE OF HYPERSOFT SET

We define the weighted table of the reduct hypersoft set $(F, B_1 \times B_2 \times B_3)$ will have entries $d_{ij} = H_{ij} \times W_j$ instead of 0 and 1 only, where H_{ij} are entries in the table of the reduct hypersoft set of $(F, B_1 \times B_2 \times B_3)$

4.7 WEIGHTED CHOICE VALUE OF THE SANITIZER

The weighted choice value of the sanitizer $H_i \in U$ is Wc_i given by

$$Wc_i = \sum d_{ij} \quad \text{where } d_{ij} = H_{ij} \times W_j$$

Imposing weights on his choice parameters, the customer could use the following revised algorithm for arriving at his final decision.

4.8 REVISED ALGORITHM FOR FINDING BEST SANITIZER

The following revised algorithm for selecting the best sanitizer is

- Input the Hyper soft set $(F, E_1 \times E_2 \times E_3)$
- Input the set $A_1 \times A_2 \times A_3$ of the choice parameters of the customer which is subset of $E_1 \times E_2 \times E_3$
- Find all the reduct hyper soft sets of $(F, A_1 \times A_2 \times A_3)$
- Choose one reduced hypersoft set say $(F, B_1 \times B_2 \times B_3)$ of $(F, A_1 \times A_2 \times A_3)$
- Find weighted table of the hypersoft set $(F, B_1 \times B_2 \times B_3)$ according to the weights decided by the customer
- Find k, for which $Wc_k = \max Wc_i$

Then P_k is the optimal choice object. If k has more than one value, then any one of them could be chosen by the customer using his option. Let us solve now the original problem using the weighted algorithm. Suppose that the Customer assigns the following weights for the parameters of A_1, A_2 and A_3 as follows.

For the parameter "71 - 75 %" put $w_1 = 0.2$

For the parameter "76 - 80 %" put $w_2 = 0.3$

For the parameter "81 – 90 %" put $w_3 = 0.5$

For the parameter "Aloe vera" put $w_4 = 0.7$

For the parameter "Neem" put $w_5 = 0.1$

For the parameter "Citrus" put $w_6 = 0.4$

For the parameter "Cheap" put $w_7 = 0.6$

For the parameter "Costly" put $w_8 = 0.1$

Using these weights the reduct hypersoft set can be tabulated as in Table-6

Table-6

U / W	$W_1 = w_2 + w_4 + w_7$ $W_1 = 1.3$	$W_2 = w_2 + w_5 + w_8$ $W_2 = 0.5$	$W_3 = w_1 + w_5 + w_8$ $W_3 = 0.4$	Weighted Choice value Wc_i
H_1	1.3	0	0.4	1.7
H_2	1.3	0.5	0.4	2.2
H_3	0	0.5	0.4	0.9
H_4	1.3	0.5	0	1.8
H_5	1.3	0	0	1.3
H_6	0	0.5	0	0.5
H_7	0	0	0	0

From Table, it is clear that the Customer finds that H_2 is the best Sanitizer according to his choice parameters in $A_1 \times A_2 \times A_3$.

5. CONCLUSION

The process of selecting the best from the list of alternatives available for selection is called decision making. Decision either is a day-to-day decision or a sensitive one which has greater impact to the organization or a society. The decision making method requires a systematic procedure to define parameters which are necessary to take final decision as well as focused on how to bring accuracy for collecting data for different parameters. We have summarized the basic concepts of Hyper soft set theory and enumerate some of its various applications in different direction to date. Hyper soft set is an important instrument for dealing with uncertainty problems. We have applied the hyper soft set theory in the case of persons who are affected with Covid-19 infection and in finding the best hand sanitizer.

REFERENCES

[1] Chen, D. Tsang, E, C, C. Yeung, D, S. and Wang, X. 2005. The parameterization reduction of soft sets and its applications, Computers and mathematics with applications, Volume 49.

[2] Maji, P, K. Biswas, R. and Roy, A, R. An application of soft sets in a decision making problem, Computers and mathematics with applications, Volume 45.

[3] Maji, P, K. Biswas, R. and Roy, A, R. 2001. Fuzzy soft sets, Journal of fuzzy mathematics, Volume 3, pp 589 - 602.

[4] Maji, P, K. Biswas, R. and Roy, R. 2003. Soft set theory, Computers and mathematics with applications, Volume 45, pp 555 - 562.

[5] Molodstov, D, A. 1999. Soft set theory first result, Computers and mathematics with applications, Volume 37, pp 19 – 31.

[6] Mujahid Abbas. Ghulam Murtaza. and Florentin Smarandache. 2020. Basic operations on hypersoft sets and hypersoft point, Neutrosophic sets and Systems, Volume 35.

[7] Nivetha martin. Florentin Smarandache. and Said broumi. 2021. Covid-19 Decision making model using extended plithogenic hypersoft sets with dual dominant attributes, International journal of neutrosophic science , volume 13, pp 75 - 86.

[8] Smarandache, F. 2018. Extension of soft Set to hypersoft Set, and then to plithogenic hypersoft set, Neutrosophic sets and systems, Volume 22, pp 168 - 170.

[9] Subrahmanyeswara rao, B. and Siva kumar, H. 2020. Soft set application in decision making problem: Covid - 19 pandemic, Alochana chakra journal, Volume 9.

[10] Wei, C. Andria. Xiao, A. Wei, H, W. and Lai, C, S. 2016. A new fuzzy decision-making approach for selecting new product development project, Concurrent engineering, volume 24, No.2, pp 240 - 250.