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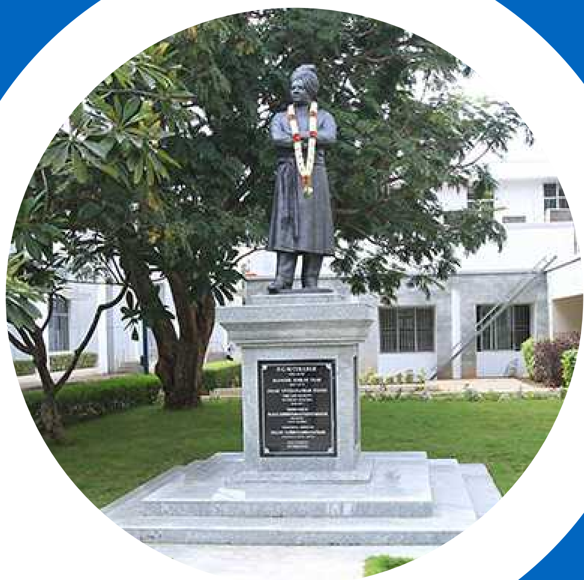

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EMERGING TRENDS IN SCIENCE AND TECHNOLOGY (ETIST-2021)

27th October 2021

Jointly Organized by

Department of Biological Science, Physical Science and Computational Science

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ABOUT THE INSTITUTION

A nations's growth is in proportion to education and intelligence spread among the masses. Having this idealistic vision, two great philanthropists late. S.P. Nallamuthu Gounder and Late. Arutchelver Padmabhushan Dr.N.Mahalingam formed an organization called Pollachi Kalvi Kazhagam, which started NGM College in 1957, to impart holistic education with an objective to cater to the higher educational needs of those who wish to aspire for excellence in knowledge and values. The College has achieved greater academic distinctions with the introduction of autonomous system from the academic year 1987-88. The college has been Re-Accredited by NAAC and it is ISO 9001 : 2015 Certified Institution. The total student strength is around 6000. Having celebrated its Diamond Jubilee in 2017, the college has blossomed into a premier Post-Graduate and Research Institution, offering 26 UG, 12 PG, 13 M.Phil and 10 Ph.D Programmes, apart from Diploma and Certificate Courses. The college has been ranked within Top 100 (72nd Rank) in India by NIRF 2021.

ABOUT CONFERENCE

The International conference on “Emerging Trends in Science and Technology (ETIST-2021)” is being jointly organized by Departments of Biological Science, Physical Science and Computational Science - Nallamuthu Gounder Mahalingam College, Pollachi along with ISTE, CSI, IETE, IEE & RIYASA LABS on 27th OCT 2021. The Conference will provide common platform for faculties, research scholars, industrialists to exchange and discus the innovative ideas and will promote to work in interdisciplinary mode.

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Product Hypersoft Matrices and its Applications in Multi-Attribute Decision Making Problems

Dr. V. Inthumathi [1] - M. Amsaveni [2]

ABSTRACT: The aim of this paper is to provide an application of hypersoft matrices in a decision making problems.
Keywords: Soft sets, hypersoft sets, hypersoft matrices, max-max decision making, products of hypersoft matrices

1. INTRODUCTION

Molodtsov [1] defined Soft set as a mathematical tool to deal with uncertainities associated with real world problems. By definition, soft set can be identified by a pair (F, A) where F stands for a multi-valued function defined on the set of parameters A. Using the concept of soft sets, many Mathematicians gave several applications in decision making problem. In [13,14], Inthumathi et al. presented some applications about soft matrices and vague soft matrices in decision making problems.

Florentin Smarandache [15] generalized the soft set to the hypersoft set by transforming the function F into a multi-attribute function defined on the cartesian product of n different sets of parameters. This concept is more flexible than soft set and more suitable in the context of decision making problems. The notion of hypersoft set will attract the attention of researchers working on soft set theory and its diverse applications. Mujahid Abbas et al. [17] defined the basic operations like union, intersection and difference of hypersoft sets. Also they have introduced hypersoft points and some basic properties of these points which laid the foundation for the hyper soft functions. Muhammad Saeed et al. [16] introduced the fundamentals of hypersoft set such as hypersoft subset, complement, Not hypersoft set and aggregation operators. Also they defined the hypersoft set relation and their sub relations, complement relations, functions, matrices.

In this work, we define products of hypersoft matrices and construct a hypersoft max-max decision making method which can be successfully applied to the Decision making problems.

2. PRELIMINARIES

Definition : 2.1 [1]

Let U be an initial universal set, E be a set of parameters and P(U) be the power set of U. A pair (F, E) is called a soft set over U, where F is a mapping from E into the set of all subsets of the set U.

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Example : 2.2

Suppose that U = {u_1, u_2, u_3, u_4} is the universe contains four cars under consideration in an auto agent and E = {x_1 = safety, x_2 = cheap. x_3 = modern and x_4 = large} is the set of parameters. A customer to select a car from the auto agent, can construct soft set S that describes the characteristic of cars according to own requests. Assume that f(x_1) = {u_1, u_2}, f(x_2) = { u_1, u_2, u_4}, f(x_3) = ϕ, f(x_4) = U. Then the soft set S is written by S = {(x_1,{u_1,u_2}), (x_2,{u_1,u_2,u_4}),(x_4,U)}.

Definition : 2.3 [8]

Let (F, A) be a soft set defined over the universe U. Then a soft matrix over (F, A) is denoted by [M (F, A)] is a matrix whose elements are the elements of the soft set (F, A).

Mathematically, [M(F, A)] = (m_{ij}) where m_{ij} = F(α) some $\alpha \in A$.

Example : 2.4

Let us consider A = E = {e_1, e_2,....,e_{10}} and U = {b_1,b_2,b_3,b_4,b_5} where (F, A) = {F(e_1) = stylish bikes= {b_2,b_4,b_5}, F(e_2) = heavy duty bikes = {b_1,b_2,b_3}, F(e_3) = light bikes= {b_1,b_2}, F(e_4) = steel body bikes = {b_3,b_5}, F(e_5) = cheap bikes = {b_1,b_3,b_5}, F(e_6) = good mileage bikes = {b_2, b_5}, F(e_7) = easily started bikes = {b_3,b_4}, F(e_8) = long driven bikes = {b_1,b_3,b_4}, F(e_9) = costly bikes = {b_2,b_4,}, F(e_{10}) = fiber body bikes = {b_1,b_2,b_4} }.

$$\left[M\left(F,A\right)\right]=\begin{bmatrix} heavy\ duty\ bikes & cheap\ bikes & stylish\ bikes \\ \{b_1,b_2,b_3\} & \{b_1,b_2,b_3\} & \{b_2,b_4,b_5\} \\ light\ bikes & good\ Mileage\ bikes & costly\ bikes \\ \{b_1,b_2\} & \{b_2,b_5\} & \{b_2,b_4\} \\ cheap\ bikes & light\ bikes & long\ driven\ bikes \\ \{b_1,b_3,b_5\} & \{b_1,b_2,b_3\} & \{b_1,b_3,b_4\} \end{bmatrix}$$

Here we see that all the elements of the matrix [M(F,A)] are of the soft set (F, A). Hence the above matrix is a soft matrix.

Definition: 2.5 [16]

Let U be a universe of discourse, P(U) the power set of U. Let a_1, a_2....,a_n for n≥1, be n distinct attributes, whose corresponding attribute values are respectively the sets A_1,A_2,...., A_n with $A_i \cap A_j = \phi$, for i≠j, and i,j∈{1,2,....,n}. Then the pair (F, A_1xA_2x...xA_n) where F: A_1xA_2x...xA_n $\rightarrow$ P(U) is called a hypersoft set over U.

Example : 2.6

Let U = {R_1, R_2, R_3, R_4, R_5} is the universal set, where R_1, R_2, R_3, R_4, R_5 represent the Refrigerators. Mr.X, Mrs.X goes to market and wants to buy such Refrigerator which is feasible and having more characteristic than that their expectation level.

Let a_1 = size, a_2 = freezing point, a_3 = pressure, a_4 = price be the attributes whose attribute values belonging to the sets B_1,B_2,B_3,B_4 given as

B_1 = {e_1=small, e_2=medium, e_3=large}

B_2 = { e_4=low freezing point}

B_3 = { e_5 =high expectation pressure, e_6=low condensing pressure}

$B_4 = \{e_7 = \text{low price}\}$

and hypersoft set can be written as

$$(\phi, B_1xB_2\ xB_3\ xB_4) = \begin{Bmatrix} ((e_1,e_4,e_5,e_7), \{R_1,R_2,R_3\}) \\ ((e_1,e_4,e_6,e_7), \{R_1,R_2,R_4\}) \\ ((e_3,e_4,e_5,e_7), \{R_3,R_5\}) \\ ((e_3,e_4,e_6,e_7), \{R_1,R_2,R_3\}) \end{Bmatrix}$$

Definition :2.7 [16]

Let U be universe of discourse, let $a_1,a_2,...,a_n$ be the attributes whose corresponding attribute values belongs to the set $E_1,E_2,...E_n$ respectively. Let $A_1xA_2x...xA_n \subseteq E_1xE_2x...xE_n$ and ($\phi_{A1xA2x...xAn}$, $E_1xE_2x...xE_n$) be the hypersoft set over the universal set U. Then a relation $R_{A_1xA_2\text{ x...x }A_n}$ of $U\times\left(E_1\times E_2\times...\times E_n\right)$ is defined as

$$R_{A_1\times A_2\times..A_n} = \left\{(u,e):e\in A_1\times A_2\times...\times A_n,\ u\in f_{A_1\times A_2\times..A_n}(e)\right\}$$

The characteristic function of $R_{A_1xA_2\text{ x...x }A_n}$ is defined as

$$\zeta_{A_1\times A_2\times...\times A_n} : U\times A_1\times A_2\times...\times A_n \rightarrow [0,1]$$

$$H(x) = \begin{cases} 1 & if\,(u,e)\in R_{A_1\times A_2\times...\times A_n} \\ 0 & if\,(u,e)\notin R_{A_1\times A_2\times...\times A_n} \end{cases}$$

Then a hypersoft set ($\phi_{A1xA2x...xAn}$, $E_1xE_2x...xE_n$) can be represented unique in the form of matrix and it is denoted by $[x_{ij}]_{mxn.}$

$$\left[x_{ij}\right]_{m\times n} = \begin{bmatrix} x_{11} & x_{12} & . & x_{1n} \\ x_{21} & x_{22} & . & x_{2n} \\ . & . & . & . \\ x_{m1} & x_{m2} & . & x_{mn} \end{bmatrix}$$

Where

$$x_{ij} = \zeta_{A_1\times A_2\times.....\times A_n}\left(u_i, e_j\right)$$
$$e_j \in A_1\times A_2\times.....\times A_n$$

Example : 2.8

Let U = $\{w_1,w_2,w_3,w_4\}$ denotes the washing machines

Let a_1=Size, a_2=Colour, a_3=Country made be the attributes whose attribute values belongs to

$A_1 = \{e_1$=Small, e_2=Medium, e_3=Large$\}$

$A_2 = \{e_4$=White, e_5=Yellow$\}$

$A_3 = \{e_6$=Pakistan, e_7=Japan$\}$ respectively.

Then the hypersoft set is given by

$$\left(\phi, A_1\times A_2\times A_3\right) = \begin{Bmatrix} \phi\left(e_1,e_4,e_6\right) = \left(w_1,w_2\right) \\ \phi\left(e_2,e_4,e_7\right) = \left(w_1,w_4\right) \\ \phi\left(e_3,e_5,e_6\right) = \left(w_2,w_3\right) \end{Bmatrix}$$

The relation of (ϕ, $A_1xA_2\ xA_3$) is given by

$$R_{A_1\times A_2\times ..A_n} = \left\{\begin{array}{l}(e_1,e_4,e_6) = \{w_1\}\\ (e_1,e_4,e_6) =\{w_2\},\\ (e_2,e_4,e_7) =\{w_1\},\\ (e_2,e_4,e_7) =\{w_4\},\\ (e_3,e_4,e_6) =\{w_2\},\\ (e_3,e_4,e_6) =\{w_3\}\end{array}\right\}$$

We can write hypersoft matrix as follows.

$$[X_{ij}] = \begin{array}{c} \\ w_1 \\ w_2 \\ w_3 \\ w_4 \end{array} \begin{array}{c} \begin{array}{ccc} (e_1,e_4,e_6) & (e_2,e_4,e_7) & (e_3,e_4,e_6) \end{array} \\ \begin{bmatrix} 1 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} \end{array}$$

Definition : 2.9 [17]

If (ϕ, $A_1xA_2x\ldots xA_n$) and (Ψ, $B_1xB_2x\ldots xB_n$) be two hypersoft sets over the same universal sets U, then union between them is denoted by (ϕ, $A_1xA_2x\ldots xA_n$) ∪ (Ψ, $B_1xB_2x\ldots xB_n$) is hypersoft set (F,C), where C = ($A_1xA_2x\ldots xA_n$) U ($B_1xB_2x\ldots xB_n$) and ∀ e ϵ C

$$F(e) = \begin{cases} \phi(e), & \text{if } e \in (A_1xA_2x\ldots xA_n) - (B_1xB_2x\ldots xB_n) \\ \Psi(e), & \text{if } e \in (B_1xB_2x\ldots xB_n) - (A_1xA_2x\ldots xA_n) \\ \phi(e)\cup \Psi(e), & \text{if } e \in (A_1xA_2x\ldots xA_n)\cap (B_1xB_2x\ldots xB_n) \end{cases}$$

Example : 2.10

Let U = {T_1,T_2,T_3,T_4,T_5} is universal set and $A_1xA_2xA_3$and $B_1xB_2xB_3$ be the set of parameters. Now we defined the hypersoft set on it (ϕ, $A_1xA_2xA_3$) = { ((e_1,e_4,e_7),{T_1,T_2,T_3}), ((e_2,e_5,e_8),{T_4,T_5}), ((e_3,e_6,e_9),{T_2,T_3,T_5})} and (Ψ, $B_1xB_2xB_3$)= { ((e_1,e_4,e_8),{T_1,T_2}), ((e_2,e_5,e_8),{T_1,T_4,T_5}), ((e_3,e_6,e_9),{T_1,T_4}) }. Then union between them is given as follows (ϕ, $A_1xA_2xA_3$) ∪ (Ψ, $B_1xB_2xB_3$)

= { ((e_1,e_4,e_7),{T_1,T_2,T_3}), ((e_2,e_5,e_8),{T_1,T_4,T_5}), ((e_3,e_6,e_9),{T_1,T_2,T_3,T_4,T_5}),((e_1,e_4,e_8),{T_1,T_2})}

Definition : 2.11 [17]

If (ϕ, $A_1xA_2x\ldots xA_n$) and (Ψ, $B_1xB_2x\ldots xB_n$) be two hypersoft sets over the same universal sets U, then intersection between them is denoted by (ϕ, $A_1xA_2x\ldots xA_n$)∩ (Ψ,$B_1xB_2x\ldots xB_n$) is hypersoft set (F,C), where C = ($A_1xA_2x\ldots xA_n$) ∩ ($B_1xB_2x\ldots xB_n$) and ∀ e ϵ C, F(e) = ϕ(e) ∩ Ψ (e).

Example : 2.12

Let U = {T_1,T_2,T_3,T_4,T_5} is universal set and $A_1xA_2xA_3$ and $B_1xB_2xB_3$ be the set of parameters. Now we defined the hypersoft set on it (ϕ,$A_1xA_2xA_3$)={((e_1,e_4,e_7),{T_1,T_2,T_3}), ((e_2,e_5,e_8),{T_4,T_5}), ((e_3,e_6,e_9),{T_2,T_3,T_5})} and (Ψ, $B_1xB_2xB_3$)= {((e_1,e_4,e_8),{T_1,T_2}),((e_2,e_5,e_8),{T_1,T_4,T_5}),((e_3,e_6,e_8),{T_1,T_4})}. Then intersection between them is given as follows (ϕ, $A_1xA_2xA_3$) ∩ (Ψ, $B_1xB_2xB_3$) = {((e_2,e_5,e_8),{T_4,T_5})}

3. PRODUCT HYPERSOFT MATRICES

In this section, we define new notions of hypersoft matrices called product hypersoft matrices.

Definition 3.1

Let U be the universal set. Let (ϕ, $A_1xA_2x...xA_n$) and (ψ, $B_1xB_2x....xB_n$) be two hypersoft sets over common universe. Then the cartesian product hypersoft sets

$$(\phi, A_1\times A_2\times....\times A_n)\times(\psi,\ B_1\times B_2\times....\times B_n)=\left(H,(A_1\times A_2\times....\times A_n)\times(B_1\times B_2\times....\times B_n)\right)$$

We define the relation of $\left(\mathrm{H},\left((A_1\times A_2\times....\times A_n)\times(B_1\times B_2\times....\times B_n)\right)\right)$ is

$$R_{(\mathrm{H},((A_1\times A_2\times...\times A_n)\times(B_1\times B_2\times...\times B_n)))}=\left\{(h,e):h\in H,e\in(A_1\times A_2\times....\times A_n)\times(B_1\times B_2\times....\times B_n)\right\}$$

The special function of R is written by

ξ: U X ($E_1XE_2X\ldots E_n$) → { 0, ½, 1 }

$$\xi=\begin{cases}1 & if\ (h,e)\in\left(A_1\times A_2\times....\times A_n\right)\cap\left(B_1\times B_2\times....\times B_n\right)\\ \frac{1}{2}=0.5 & if\ (h,e)\in\left(A_1\times A_2\times....\times A_n\right)\cup\left(B_1\times B_2\times....\times B_n\right)\\ 0 & if\ (h,e)\notin\left(A_1\times A_2\times....\times A_n\right)\cup\left(B_1\times B_2\times....\times B_n\right)\end{cases}$$

If (d_{ij}) = d(h,e), we define a matrix

$$\left(d_{ij}\right)_{n\times p}=\begin{bmatrix}d_{11} & d_{12} & ... & d_{1p}\\ d_{21} & d_{22} & ... & d_{2p}\\ . & . & ... & .\\ . & . & ... & .\\ d_{n1} & d_{n2} & ... & d_{np}\end{bmatrix}$$

is called as a product hypersoft matrix, where n is the number of elements in U and p is the product of the number of elements in the $\left(A_1\times A_2\times....\times A_n\right)$ and $\left(B_1\times B_2\times....\times B_n\right)$

Example 3.2

Let U = {m_1, m_2, m_3, m_4}

Define the attributes sets by

E_1 = {x_{11}, x_{12}}, E_2 = {x_{21}, x_{22}}, E_3 = {x_{31}, x_{32}}

Suppose that

$$A_1=\left\{x_{11},x_{12}\right\},A_2=\left\{x_{21},x_{22}\right\},A_3=\left\{x_{31}\right\}$$
$$and\ B_1=\left\{x_{11}\right\},B_2=\left\{x_{21,}x_{22}\right\},B_3=\left\{x_{31,}x_{32}\right\}$$

are subsets of E_i for each i=1,2,3.

Let the hypersoft sets $(\phi, A_1 \times A_2 \times A_3)$ and $(\psi, B_1 \times B_2 \times B_3)$ be defined by

$$(\phi,\ A_1 \times A_2 \times A_3) = \begin{Bmatrix} \{(x_{11}, x_{22}, x_{31}), \{m_2\}\}, \\ \{(x_{12}, x_{21}, x_{31}), \{m_3, m_4\}\} \end{Bmatrix}$$

and

$$(\psi, B_1 \times B_2 \times B_3) = \begin{Bmatrix} \{\{(x_{11}, x_{21}, x_{31}), \{m_2, m_3\}\}, \\ \{(x_{11}, x_{22}, x_{32}), \{m_3, m_4\}\}\} \end{Bmatrix}$$

Here,

$$(\phi, A_1 \times A_2 \times A_3) \times (\psi, B_1 \times B_2 \times B_3) = \begin{Bmatrix} \{(x_{11}, x_{22}, x_{31}), (x_{11}, x_{21}, x_{31})\}, \\ ((x_{11}, x_{22}, x_{31}), (x_{11}, x_{22}, x_{33})), \\ ((x_{12}, x_{21}, x_{31}), (x_{11}, x_{21}, x_{31})), \\ ((x_{12}, x_{21}, x_{31}), (x_{11}, x_{22}, x_{33}))\} \end{Bmatrix}$$

Then the relation form

$$R_{(H,(A_1 \times A_2 \times A_3) \times (B_1 \times B_2 \times B_3))} = \begin{Bmatrix} \{\{(x_{11}, x_{22}, x_{31}), (x_{11}, x_{21}, x_{31})\}, \{(m_2, m_2), (m_2, m_3)\} \\ \{(x_{11}, x_{22}, x_{31}), (x_{11}, x_{22}, x_{33})\}, \{(m_2, m_3), (m_2, m_4)\} \\ \{(x_{12}, x_{21}, x_{31}), (x_{11}, x_{22}, x_{33}), \{(m_3, m_2), (m_3, m_3), (m_4, m_2), (m_4, m_3)\}\} \\ \{(x_{12}, x_{21}, x_{31}), (x_{11}, x_{22}, x_{33}), \{(m_3, m_3), (m_3, m_4), (m_4, m_3), (m_4, m_4)\}\} \end{Bmatrix}$$

Definition 3.3

Let $(\phi, A_1 \times A_2 \times .... \times A_n) = (a_{ij})$ and $(\psi, B_1 \times B_2 \times .... \times B_n) = (b_{ij})$ are two hyper soft matrices. Then the AND product (ϕ, $A_1xA_2x...xA_n$) AND (ψ, $B_1xB_2x....xB_n$) is denoted by

$$\left[\left(\phi\left(A_1 \times A_2 \times .... \times A_n\right)\right)\right] \wedge \left[\left(\Psi\left(B_1 \times B_2 \times .... \times B_n\right)\right)\right] = \left[H((A_1 \times A_2 \times .... \times A_n) \times ((B_1 \times B_2 \times .... \times B_n))\right] = d_{ij}$$

is a hypersoft matrix, and is defined by $(d_{ij}) = (a_{ij}) \cap (b_{ij})$.

Example 3.4

Let U = {m_1, m_2, m_3, m_4, m_5, m_6, m_7}

Define the attribute sets by

E_1 = {e_1, e_2, e_3, e_4} E_2 = {e_5, e_6, e_7} E_3 = {e_8, e_9}

Suppose that

A_1 = {e_1, e_2, e_4} A_2 = {e_5, e_7} A_3 = {e_9}

B_1 = {e_2, e_3, e_4} B_2 = {e_5, e_6} B_3 = {e_8}

are subsets E_i for i = 1,2,3.

Consider the hypersoft sets

$$\left(\phi, A_1\times A_2\times A_3\right)=\left\{\begin{array}{l}\left\{\left\{\left(e_1,e_5,e_9\right),\left(m_1,m_3,\mathrm{m}_{5,}m_6\right)\right\}\right\}\\ \left\{\left(e_2,e_7,e_9\right),\left(m_2,m_4,m_5,m_7\right)\right\}\\ \left\{\left(e_4,e_5,e_9\right),\left(m_3,m_5,m_7\right)\right\}\end{array}\right\}$$

$$\left(\psi, B_1\times B_2\times B_3\right)=\left\{\begin{array}{l}\left\{\left\{\left(e_2,e_5,e_8\right),\left(m_2,m_4,m_6,m_7\right)\right\}\right\}\\ \left\{\left(e_3,e_5,e_8\right),\left(m_1,m_3,m_5,m_7\right)\right\}\\ \left\{\left(e_4,e_6,e_8\right),\left(m_7,m_2,m_4\right)\right\}\end{array}\right\}$$

Hence

$$\left(\phi, A_1\times A_2\times A_3\right)\Lambda\left(\psi, B_1\times B_2\times B_3\right)=\left\{\begin{array}{l}\left\{\left(\left(e_1,e_5,e_9\right),\left(e_2,e_5,e_8\right)\right),\left\{\mathrm{m}_6\right\}\right\}\\ \left\{\left(\left(e_1,e_5,e_9\right),\left(e_3,e_5,e_8\right)\right),\left\{\mathrm{m}_1,\mathrm{m}_3,\mathrm{m}_5\right\}\right\}\\ \left\{\left(\left(e_1,e_5,e_9\right),\left(e_4,e_6,e_8\right)\right),\left\{\phi\right\}\right\}\\ \left\{\left(\left(e_2,e_7,e_9\right),\left(e_2,e_5,e_8\right)\right),\left\{\mathrm{m}_2,\mathrm{m}_4,\mathrm{m}_7\right\}\right\}\\ \left\{\left(\left(e_2,e_7,e_9\right),\left(e_3,e_5,e_8\right)\right),\left\{m_5,\mathrm{m}_7\right\}\right\}\\ \left\{\left(\left(e_2,e_7,e_9\right),\left(e_4,e_6,e_8\right)\right),\left\{\mathrm{m}_2,\mathrm{m}_4,\mathrm{m}_7\right\}\right\}\\ \left\{\left(\left(e_4,e_5,e_9\right),\left(e_2,e_5,e_8\right)\right),\left\{m_7\right\}\right\}\\ \left\{\left(\left(e_4,e_5,e_9\right),\left(e_3,e_5,e_8\right)\right),\left\{\mathrm{m}_3,m_5,\mathrm{m}_7\right\}\right\}\\ \left\{\left(\left(e_4,e_5,e_9\right),\left(e_4,e_6,e_8\right)\right),\left\{\mathrm{m}_7\right\}\right\}\end{array}\right\}$$

Hence the product hypersoft matrix is

$$\left(dij\right)_{7\times 9}=\begin{pmatrix}0&1&0&0&0&0&0&0&0\\0&0&0&1&0&1&0&0&0\\0&1&0&0&0&0&0&1&0\\0&0&0&1&0&1&0&0&0\\0&1&0&0&1&0&0&1&0\\1&0&0&0&0&0&0&0&0\\0&0&0&1&1&1&1&1&1\end{pmatrix}$$

Definition 3.5

Let $(\phi, A_1 \times A_2 \times .... \times A_n) = (a_{ij})$ and $(\psi, B_1 \times B_2 \times .... \times B_n) = (b_{ij})$ are two hyper soft matrices. Then OR product $(\phi, A_1xA_2x...xA_n)$ OR $(\psi, B_1xB_2x....xB_n)$ is denoted by

$$[\phi, A_1 \times A_2 \times .... \times A_n] \vee [\psi, B_1 \times B_2 \times .... \times B_n] = [H, ((A_1 \times A_2 \times .... \times A_n) \times (B_1 \times B_2 \times .... \times B_n))] = (d_{ij})$$

is a hypersoft matrix is defined by $(d_{ij}) = (a_{ij}) \cup (b_{ij})$.

Example 3.6

In the previous example,

$$(\phi, A_1 \times A_2 \times A_3) \vee (\psi, B_1 \times B_2 \times B_3) = \left\{ \begin{array}{l} \{((e_1,e_5,e_9),(e_2,e_5,e_8)),\{m_1,m_2,m_3,m_4,m_5,m_6,m_7\}\} \\ \{((e_1,e_5,e_9),(e_3,e_5,e_8)),\{m_1,m_3,m_5,m_6,m_7,\}\} \\ \{((e_1,e_5,e_9),(e_4,e_6,e_8)),\{m_1,m_2,m_3,m_4,m_5,m_6,m_7\}\} \\ \{((e_2,e_7,e_9),(e_2,e_5,e_8)),\{m_2,m_4,m_5,m_6,m_7\}\} \\ \{((e_2,e_7,e_9),(e_3,e_5,e_8)),\{m_1,m_2,m_3,m_4,m_5,m_7\}\} \\ \{((e_2,e_7,e_9),(e_4,e_6,e_8)),\{m_2,m_4,m_5,m_7\}\} \\ \{((e_4,e_5,e_9),(e_2,e_5,e_8)),\{m_2,m_3,m_4,m_5,m_6,m_7\}\} \\ \{((e_4,e_5,e_9),(e_3,e_5,e_8)),\{m_1,m_3,m_5,m_7\}\} \\ \{((e_4,e_5,e_9),(e_4,e_6,e_8)),\{m_2,m_3,m_4,m_5,m_7\}\} \end{array} \right\}$$

Hence the product hypersoft matrix is

$$(d_{ij}) = \begin{bmatrix} 0.5 & 1 & 0.5 & 0 & 0.5 & 0 & 0 & 0.5 & 0 \\ 0.5 & 0 & 0.5 & 1 & 0.5 & 1 & 0.5 & 0 & 0.5 \\ 0.5 & 1 & 0.5 & 0 & 0.5 & 0 & 0.5 & 1 & 0.5 \\ 0.5 & 0 & 0.5 & 1 & 0.5 & 1 & 0.5 & 0 & 0.5 \\ 0.5 & 1 & 0.5 & 0.5 & 1 & 0.5 & 0.5 & 1 & 0.5 \\ 1 & 0.5 & 0.5 & 0.5 & 0 & 0 & 0.5 & 0 & 0 \\ 0.5 & 0.5 & 0.5 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

4. APPLICATION OF HYPERSOFT MATRICES

Definition 4.1

The choice value of an object $d_j \in U$ is defined by $d_j = \max\{\max(d(h,e))\}$ where $d(h,e)$ are the entries of d_{ij}.

Definition 4.2

Let U = {m_1, m_2,....,m_n} be an initial universe and max{max(d(h,e))} = [u_{i1}]. Then a subset of U can be obtained by using [u_{i1}] as in the following way. Opt [u_{i1}] = { u_i : u_i ϵ U, u_{i1} = max (1 or ½)
which is called an optimum set of U.

Algorithm 4.3

Assume that a set of alternative and a set of paramaters are given. Now we can construct of hypersoft max-max decision making method by the following algorithm.

- Choose feasible subsets of the set of parameters.
- Construct the OR product hypersoft set
- Find an OR product of the hypersoft matrices.
- Compute the max-max decision matrix of the product
- Find an optimum set of U.

In this section, we present an application of hypersoft matrices in a decision making problem.
Let us now formulate our problem as follows :

Problem

Let U = {L_1, L_2, L_3,....,L_7} be the set of 7 Laptops.

Let a_1 = Name of the company

a_2 = Ram

a_3 = Country made

be the attributes whose attribute values belonging to the sets E_1, E_2, E_3 given as

$$E_1 = \{e_1 = Acer, e_2 = Apple, e_3 = Dell, e_4 = HB\}$$
$$E_2 = \{e_3 = 4GB, e_6 = 8GB, e_7 = 16GB\}$$
$$E_3 = \{e_8 = China, e_9 = India, e_{10} = Japan, e_{11} = USA\}$$

Suppose that the two friends Mr.X and Mr.Y have to choose the sets of their parameters

$$A_1 = \{e_1 = Acer, e_3 = Dell\}$$
$$A_2 = \{e_5 = 4GB, e_7 = 16GB\}$$
$$A_3 = \{e_8 = India, e_{11} = USA\}$$

and

$$B_1 = \{e_3 = Dell, e_4 = HB\}$$
$$B_2 = \{e_6 = 8GB, e_7 = 16GB\}$$
$$B_3 = \{e_8 = China, e_{10} = Japan\}$$

The problem is to select the Laptop which is most suitable with the choice parameters of both Mr.X and Mr.Y.
Now we use the above algorithm to solve our problem.
Consider the hyper soft sets

$$\left(\phi, A_1\times A_2\times A_3\right)=\begin{Bmatrix}\{e_1,e_7,e_8\},\{L_3,L_4,L_7\}\\ \{e_3,e_5,e_{11}\},\{L_2,L_1,L_5\}\\ \{e_3,e_7,e_8\},\{L_5,L_6,L_7\}\end{Bmatrix}$$

$$\left(\psi, B_1\times B_2\times B_3\right)=\begin{Bmatrix}\{e_4,e_6,e_8\},\{L_2,L_4,L_7\}\\ \{e_3,e_7,e_{10}\},\{L_5,L_3,L_7\}\\ \{e_4,e_7,e_8\},\{L_1,L_6\}\end{Bmatrix}$$

The OR product Hypersoft set is

$$\left(\phi, A_1\times A_2\times A_3\right)\vee\left(\psi, B_1\times B_2\times B_3\right)=\begin{Bmatrix}\{((e_1,e_7,e_8),(e_4,e_6,e_8)),\{L_2,L_3,L_4,L_7\}\}\\ \{((e_1,e_7,e_8),(e_3,e_7,e_{10})),\{L_4,L_5,L_3,L_7\}\}\\ \{((e_1,e_7,e_8),(e_4,e_7,e_8)),\{L_1,L_3,L_4,L_6,L_7\}\}\\ \{((e_3,e_5,e_{11}),(e_4,e_6,e_8)),\{L_1,L_2,L_4,L_5,L_7\}\}\\ \{((e_3,e_6,e_{11}),(e_3,e_7,e_{10})),\{L_3,L_4,L_5,L_7\}\}\\ \{((e_3,e_5,e_{11}),(e_4,e_7,e_8)),\{L_1,L_2,L_5,L_6\}\}\\ \{((e_3,e_7,e_8),(e_4,e_6,e_8)),\{L_2,L_4,L_5,L_6,L_7\}\}\\ \{((e_3,e_7,e_8),(e_3,e_7,e_{10})),\{L_3,L_5,L_6,L_7\}\}\\ \{((e_3,e_7,e_8),(e_4,e_7,e_8)),\{L_1,L_5,L_6,L_7\}\}\end{Bmatrix}$$

Hence the OR-product hypersoft matrix is

$$\left(d_{ij}\right)_{7\times 9}=\begin{bmatrix}0 & 0 & 0.5 & 0.5 & 0 & 1 & 0 & 0 & 0.5\\ 0.5 & 0 & 0 & 1 & 0 & 0.5 & 0.5 & 0 & 0\\ 0.5 & 1 & 0.5 & 0 & 1 & 0 & 0 & 0.5 & 0\\ 1 & 0.5 & 0.5 & 0.5 & 0.5 & 0 & 0.5 & 0 & 0\\ 0 & 0.5 & 0 & 0.5 & 0.5 & 0.5 & 0.5 & 1 & 0.5\\ 0 & 0 & 0.5 & 0 & 0 & 0.5 & 0.5 & 0.5 & 1\\ 1 & 1 & 0.5 & 0.5 & 1 & 0 & 1 & 1 & 0.5\end{bmatrix}$$

We can find a max-max decision hypersoft matrix as

Max {Max Values is every column} =

$$\text{Max} = \begin{Bmatrix} \{L_4, L_7\}, \{L_3, L_7\}, \{L_1, L_3, L_4, L_6, L_7\}, \{L_3\}, \\ \{L_3, L_7\}, \{L_1\}, \{L_5, L_7\}, \{L_6\}, \{L_7\} \end{Bmatrix}$$

$$= L_7$$

$$and\left(d_j\right) = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}^T$$

Finally, we can find an optimum set of U according to

$$Max\left\{Max\left(d\left(h,e\right)\right)\right\} = \left[u_{i1}\right] = L_7$$

where L_7 is an optimum Laptop to buy for Mr.X and Mr.Y.

Definition 4.4

Let $\left(\phi, A_1 \times A_2 \times .... \times A_n\right) = \left(a_{ij}\right)$, $\left(\psi, B_1 \times B_2 \times .... \times B_n\right) = \left(b_{ij}\right)$ and $\left(\chi, C_1 \times C_2 \times ...... \times C_n\right) = \left(C_{ij}\right)$ are three hypersoft matrices.

Then (ϕ, A_1xA_2x...xA_n) OR (ψ, B_1xB_2x....xB_n) OR (χ, C_1 x C_2 x…xC_n) is denoted by

$$\left(\phi, A_1 \times A_2 \times ...... \times A_n\right) \vee \left(\psi, B_1 \times B_2 \times ...... \times B_n\right) \vee \left(\chi, C_1 \times C_2 \times ...... \times C_n\right)$$

$$= \left[H_1\left(\left(A_1 \times A_2 \times ...... \times A_n\right) \times \left(B_1 \times B_2 \times ...... \times B_n\right) \vee \left(C_1 \times C_2 \times ...... \times C_n\right)\right)\right]$$

$$= \left(d_{ij}\right)$$

is a hypersoft matrix is defined by

$$\left(d_{ij}\right) = \left(a_{ij}\right) \cup \left(b_{ij}\right) \cup \left(c_{ij}\right)$$

Problem

Let $U = \{T_1, T_2, ..., T_5\}$ be the set of 5 Televisions.

Let a_1 = Name of the company

a_2 = Model

a_3 = Size

be the attributes whose attribute values belonging to the sets E_1, E_2, E_3 given as

E_1 = {e_1 = LG, e_2 = Philips, e_3 = Sony}

E_2 = {e_4 = LCD, e_5 = LED, e_6 = Smart}

E_3 = {e_7 = Medium, e_8 = Large}

Suppose that the three friends Mr.X, Mr.Y and Mr.Z have to choose the set of their parameters.

A_1 = {e_1=LG, e_3=Sony}

A_2 = {e_5=LED, e_6=Smart}

A_3 = {e_7=Medium}

B_1 = {e_2=Philips, e_3=Sony}

B_2 = {e_4=LCD, e_6=Smart}

B_3 = {e_8=Large}

and

$C_1 = \{e_1=\text{LG}, e_2=\text{Philips}\}$

$C_2 = \{e_4=\text{LCD}, e_5=\text{LED}\}$

$C_3 = \{e_8=\text{Large}\}$

The problem is to select the television which is most suitable with the choice parameters of Mr. X, Mr. Y and Mr. Z.

Now we use the algorithm to solve our problem.

Consider the hypersoft sets

$$(\phi, A_1 \times A_2 \times A_3) = \begin{Bmatrix} \{e_1, e_5, e_7\}, \{T_1, T_3, T_5\} \\ \{e_3, e_6, e_7\}, \{T_2, T_3, T_5\} \end{Bmatrix}$$

$$(\psi, B_1 \times B_2 \times B_3) = \begin{Bmatrix} \{e_2, e_4, e_8\}, \{T_2, T_3\} \\ \{e_3, e_6, e_8\}, \{T_1, T_3, T_4, T_5\} \end{Bmatrix}$$

$$(\chi, C_1 \times C_2 \times C_3) = \begin{Bmatrix} \{e_1, e_4, e_8\}, \{T_1, T_2, T_3\} \\ \{e_2, e_5, e_8\}, \{T_4, T_5\} \end{Bmatrix}$$

The OR product hypersoft sets are

$$(\phi, A_1 \times A_2 \times A_3) \vee (\psi, B_1 \times B_2 \times B_3) \vee (\chi, C_1 \times C_2 \times C_3) = \begin{Bmatrix} \{(e_1,e_5,e_7),(e_2,e_4,e_8),(e_1,e_4,e_8),\{T_1,T_2,T_3,T_5\}\} \\ \{(e_1,e_5,e_7),(e_2,e_4,e_8),(e_2,e_5,e_8),\{T_1,T_2,T_3,T_4,T_5\}\} \\ \{(e_1,e_5,e_7),(e_3,e_6,e_8),(e_1,e_4,e_8),\{T_1,T_2,T_3,T_4,T_5\}\} \\ \{(e_1,e_5,e_7),(e_3,e_6,e_8),(e_2,e_5,e_8),\{T_1,T_3,T_4,T_5\}\} \\ \{(e_3,e_6,e_7),(e_2,e_4,e_8),(e_1,e_4,e_8),\{T_1,T_2,T_3,T_5\}\} \\ \{(e_3,e_6,e_7),(e_2,e_4,e_8),(e_2,e_5,e_8),\{T_2,T_3,T_4,T_5\}\} \\ \{(e_3,e_6,e_7),(e_3,e_6,e_8),(e_1,e_4,e_8),\{T_1,T_2,T_3,T_4,T_5\}\} \\ \{(e_3,e_6,e_7),(e_3,e_6,e_8),(e_2,e_5,e_8),\{T_1,T_2,T_3,T_4,T_5\}\} \end{Bmatrix}$$

Now we can find a Cartesian product of the hypersoft matrix ϕ, ψ and χ by using OR product as follow

$$\left(d_{ij}\right)_{5\times 8} = \begin{bmatrix} 0.5 & 0.5 & 1 & 0.5 & 0.5 & 0 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0 & 1 & 0.5 & 0.5 & 0.5 \\ 1 & 0.5 & 1 & 0.5 & 1 & 0.5 & 1 & 0.5 \\ 0 & 0.5 & 0.5 & 0.5 & 0 & 0.5 & 0.5 & 0.5 \\ 0.5 & 1 & 0.5 & 1 & 0.5 & 0.5 & 0.5 & 0.5 \end{bmatrix}$$

We can find a max-max decision hypersoft matrix as

Max {Max values in every column}

$$= Max\left\{\{T_3\},\{T_5\},\{T_1,T_3\},\{T_5\},\{T_2,T_3\},\{T_2,T_3,T_4,T_5\},\{T_3\},\{T_1,T_2,T_3,T_4,T_5\}\right\} = T_3$$

And

$$\left(d_{ij}\right) = \begin{pmatrix} 0 & 0 & 1 & 0 & 0 \end{pmatrix}^T$$

Finally Mr. X, Mr. Y and Mr. Z combinations buy the television T_3.

CONCLUSION

We have conferred a new algorithm using the product hypersoft matrix and intended a new 'OR' operations of hypersoft matrix to solve hypersoft matrix based decision making problems. The advantage of this new recommended method is that it is very helpful and easy to apply when correlated with the other methods. The work can be further extended to apply for hypersoft sets and hypersoft matrices based on decision making problems involving any number of decision makers.

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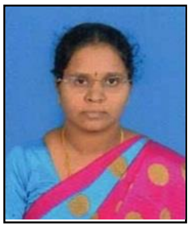

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