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# Nutrition Modeling Through Nano Topology

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**ABSTRACT**
Nutrition is the provision, to cells and organisms, of the materials necessary in the form of food to support life. Many common health problems can be prevented or alleviated with a healthy, balanced diet. The purpose of this paper is to apply topological reduction of attributes in set-valued ordered information systems in finding the key foods suitable for two age groups in order to be healthy. We have already introduced a new topology called nano topology. The tactic applied here is in terms of basis of nano topology.
***Keywords*** - Core, Dominance relation, Lower approximation, Nano-open sets , Nano topology, Set valued information system, Upper approximation

## I. INTRODUCTION

"A sound mind in a sound body" is a well-known adage. A sound body is impossible without proper food and nourishment. Healthy people have good stamina and physique, are active mentally and physically, have endurance, vigor and vitality and are good natured. There are six major classes of nutrients: carbohydrates, fats, minerals, protein, vitamins, and water, of which water is very essential. Each nutrient serves one or more of the following general functions. Carbohydrates and fats supply heat, energy and power. Proteins, minerals, vitamins build and promote growth, renew body tissues and regulate body process. For practical purposes, the recommended daily dietary allowances have been classified into the following basic food groups representedas a table as well as a food pyramid.

| Group | Food stuff | Main nutrient constitution |
|---|---|---|
| I | Vegetables and fruits | carbohydrates, vitamins,minerals |
| II | Milk and milk products | carbohydrates, protein, fats |
| III | Meat, poultry and fish | protein, fats |
| IV | Pulses and cereals | carbohydrates, protein, minerals. |
| V | Oil, ghee and butter | protein , fats |

Table 1


General Topology is vast and has many different inventions and interactions with other fields of Mathematics and Science. Topology based methods are of increasing importance in the analysis and visualization of all forms of field data.In this paper, we have used a new topology in set valued ordered information systems in finding the key foods necessary for adolescent girls and children to be healthy. The topology that we have used here is called nano topology which is named so due to its size , because it can have only a maximum of five elements in it.

## II. PRELIMINARIES

**Definition 2.1 [12]** *:*A set-valued information system is a quadruple $S = (U, A, V, f)$ where $U$ is a non-empty finite set of objects, A is a finite set of attributes, V = $\cup V_a$ where $V_a$ is a domain of the attribute 'a', $f : U \times A \to P(V)$ is a function such that for every $x \in U$ and $a \in A$, $f(x,a) \subseteq V_a$. Also we assume that $f(x,a) \geq 1$. The attribute set A is divided into two subsets- a set C condition attributes and a decision attribute, d where C $\cap \{d\} = \phi$.

**Definition 2.2 [12]** *:*If the domain of a condition attribute is ordered according to a decreasing or increasing preference, then the attribute is a criterion. If, in a set valued information system, every condition attribute is a criterion, then it is said to be a set- valued ordered information system.

**Definition 2.3 [12]** *:* If the values of some objects in $\cup$ under a condition attribute can be ordered according to an inclusion increasing or decreasing preference, then the attribute is an inclusion criterion.

**Definition 2.4 [12]** *:* Consider a set-valued ordered information system with inclusion increasing preference. Consider a relation $R_A^{\geq}$ defined as $R_A^{\geq} = \{(y,x) \in \cup \times \cup : f(y,a) \supseteq f(x,a)$ for every $a \in A\}$. $R_A^{\geq}$ is called the dominance relation on $\cup$.When (y,x) $\in R_A^{\geq}$, it is denoted by writing $y \geq_A x$ meaning that y is atleast as good as x with respect to A.

**Property 2.5 [12]** *:* The inclusion dominance relation $R_A^{\geq}$ is i) reflexive ii) unsymmetric and iii) transitive.

**Definition 2.6 [12]** *:* For $x \in \cup$, the dominance class of x is denoted by $[x]_A^{\geq}$ and is defined as $\{y \in \cup : (y,x) \in R_A^{\geq}\} = \{y \in \cup : f(y,a) \supseteq f(x,a)$ for every $a \in A\}$. $\cup_A^{\geq}$ denotes the family of dominance classes, that is, $U_A^{\geq} = \{[x]_A^{\geq} : x \in \cup\}$.

**Remark 2.7 [12]** *:* $U_A^{\geq}$ is not a partition of $\cup$, but induces a covering of $\cup$, that is $\cup = \cup [x]_A^{\geq}$ .

**Definition 2.8 [12]** *:*Given a set-valued ordered information system $S = (\cup, A, V, f)$ and a subset X of $\cup$, the upper approximation of X is defined as $\{x \in \cup : [x]_A^{\geq} \cap X \neq \phi\}$ and is denoted by $U_A^{\geq}(X)$ and the lower approximation is defined as $\{x \in U : [x]_A^{\geq} \subseteq X\}$ and is denoted by $L_A^{\geq}(X)$. The boundary region of X,denoted by $B_A^{\geq}(X) = U_A^{\geq}(X) - L_A^{\geq}(X)$.

**Definition 2.9 [12]** *:* Given a set-valued ordered information system S, a subset B of A is said to be a criterion reduction of S if $R_A^{\geq} = R_B^{\geq}$ and $R_M^{\geq} \neq R_A^{\geq}$ for any $M \subset B$. That is, a criterion reduction is a minimal attribute set B such that $R_A^{\geq} = R_B^{\geq}$ .

**Definition 2.10 [12]** *:* CORE(A) is given by $\{a \in A / R_A^{\geq} \neq R_{A-\{a\}}^{\geq}\}$.

**Example 2.11** *:* Let $\cup = \{A_1, A_2, A_3, A_4, A_5\}$ be the universe of five students in a school and A={p,q,r}, the set of attributes - language, sports and extra -curricular activities. Let $V_p$= {English, Hindi, French}, $V_q$= {Tennis,Basketball,volleyball} and $V_r$= {Swimming, Singing, Reading}. The following table represents a set valued ordered information system.

| $\cup$ | p | q | r |
|---|---|---|---|
| $A_1$ | $\{E\}$ | $\{V\}$ | $\{W\}$ |
| $A_2$ | $\{E,A\}$ | $\{V\}$ | $\{S,W\}$ |
| $A_3$ | $\{H\}$ | $\{B,V\}$ | $\{R\}$ |
| $A_4$ | $\{H,F\}$ | $\{V,T\}$ | $\{R,W,S\}$ |
| $A_5$ | $\{F\}$ | $\{T\}$ | $\{R,W\}$ |

Table 2

From the above table, $[A_1]_A^{\geq} = \{A_1, A_2\}, [A_2]_A^{\geq} = \{A_2\}, [A_3]_A^{\geq} = \{A_3\}$, and $[A_4]_A^{\geq} = \{A_4\}, [A_5]_A^{\geq} = \{A_4, A_5\}$ hence $\cup_A^{\geq} = \{[A_1]_A^{\geq}, [A_2]_A^{\geq}, [A_3]_A^{\geq}, [A_4]_A^{\geq}, [A_5]_A^{\geq}\}$. Also we note that $\bigcup_{i=1}^{5} [A_i]_A^{\geq} = \cup$.

**Definition 2.12 [6]** *:*Let $\cup$ be a non-empty finite set of objects called the universe and R be an equivalence relation on $\cup$ named as the indiscernibility relation. Elements belonging to the same equivalence class are said to be indiscernible with one another. The pair $(\cup, R)$ is said to be the approximation space. Let $X \subseteq \cup$.

(i) The lower approximation of X with respect to R is the set of all objects, which can be for certain classified as X with respect to R and its is denoted by $L_R(X)$. That is, $L_R(X) = \bigcup_{x \in \cup} \{R(x) : R(x) \subseteq X\}$, where R(x) denotes the equivalence class determined by x.

(ii) The upper approximation of X with respect to R is the set of all objects, which can be possibly classified as X with respect to R and it is denoted by

$U_R(X)$. That is, $U_R(X)$ = $\bigcup_{x\in U}\{R(x): R(x)\cap X \neq \phi\}$

(iii) The boundary region of X with respect to R is the set of all objects, which can be classified neither as X nor as not-X with respect to R and it is denoted by $B_R(X)$. That is, $B_R(X) = U_R(X) - L_R(X)$.

**Proposition 2.13 [4]:** If (U,R) is an approximation space and X, $Y \subseteq U$, then

1. $L_R(X) \subseteq X \subseteq U_R(X)$.
2. $L_R(\phi) = U_R(\phi) = \phi$ and $L_R(U) = U_R(U) = U$
3. $U_R(X \cup Y) = U_R(X) \cup U_R(Y)$
4. $U_R(X \cap Y) \subseteq U_R(X) \cap U_R(Y)$
5. $L_R(X \cup Y) \supseteq L_R(X) \cup L_R(Y)$
6. $L_R(X \cap Y) = L_R(X) \cap L_R(Y)$
7. $L_R(X) \subseteq L_R(Y)$ and $U_R(X) \subseteq U_R(Y)$ whenever $X \subseteq Y$
8. $U_R(X^c) = [L_R(X)]^c$ and $L_R(X^c) = [U_R(X)]^c$
9. $U_R U_R(X) = L_R U_R(X) = U_R(X)$
10. $L_R L_R(X) = U_R L_R(X) = L_R(X)$

**Definition 2.14 [5]** *:* Let U be the universe, R be an equivalence relation on U and $\tau_R(X) = \{U, \phi, L_R(X), U_R(X), B_R(X)\}$ where $X \subseteq U$. Then $\tau_R(X)$ satisfies the following axioms:

1. U and $\phi \in \tau_R(X)$.
2. The union of the elements of any subcollection of $\tau_R(X)$ is in $\tau_R(X)$.
3. The intersection of the elements of any finite subcollection of $\tau_R(X)$ is in $\tau_R(X)$.

That is, $\tau_R(X)$ forms a topology on U called as the nanotopology on U with respect to X. We call ( $U, \tau_R(X)$ ) as the nanotopological space. The elements of $\tau_R(X)$ are called as nano-open sets.

**Lemma 2.15[5]** *:* If $\tau_R(X)$ is the nano topology on U with respect to X, then the set B = $\{U, L_R(X), B_R(X)\}$ is the basis for $\tau_R(X)$.

**Definition 2.16** *:* $\tau_C^{\geq}(X) = \{U, \phi, U_A^{\geq}(X), L_A^{\geq}(X), B_A^{\geq}(X)\}$ is a topology on U with respect to X ( nano topology corresponding to the dominance relation $R_A^{\geq}$ ), as in definition 2.14, since the proposition 2.13 is true for $U_A^{\geq}(X)$ and $L_A^{\geq}(X)$

**Definition2.17:** In terms of basis of a nano topological space, a criterion reduction of a set valued ordered information system is a minimal attribute subset B of A such that $\beta_B = \beta_A$ and CORE(A)= $\{a \in A/ : \beta_A \neq \beta_{A-\{a\}}\}$ (or) CORE(A) = ∩ RED(A) where RED(A) denotes a criterion reduction.

The following algorithm enables us determine the CORE(A)..

**Algorithm:**

**Step 1:** Given an information system $(U, A)$ where A is divided into two classes, C of condition attributes and D of decision attribute, a dominance relation $R_C^{\geq}$ on U corresponding to C and a subset X of U, represent the data as an information table, columns of which are labelled by attributes, rows by objects and entries of the table are attribute values.

**Step 2:** Find the lower approximation $L_A^{\geq}$(X), upper approximation $U_A^{\geq}$(X) and the boundary region $B_A^{\geq}$(X) of X with respect to $R_C^{\geq}$.

**Step 3:** Generate the nano topology $\tau_C^{\geq}$(X) and its basis $\beta_C^{\geq}$(X)

**Step 4:** Remove an attribute x from C and find the lower and upper approximations and the boundary region of X with respect to the dominance relation on C -(x).

**Step 5:** Generate the nano topology $\tau_{C-\{x\}}^{\geq}(X)$ and the corresponding basis $\beta_{C-\{x\}}^{\geq}(X)$

**Step 6**: Repeat steps 4 and 5 for all attributes in C

**Step7**: Those attributes in C for which $\beta_C^{\geq}(X) \neq \beta_{C-\{x\}}^{\geq}(X)$ form the criterion reduction.

**Step 8:**If there is more than one criterion reduction, their intersection gives CORE(A).

## III. NUTRITION FOR ADOLESCENT GIRLS

Adolescence is a period of rapid growth when an individual gains 35 per cent of adult weight and 11-18 per cent of adult height. These dramatic changes in physical growth and development over a period of time have to be met with special nutrition needs. They are generally ignored in case of girls, particularly those from poor communities, resulting in stunting of their growth. It has been proved that despite continuing poverty, girls who are considerably short at five years of age register impressive increments in height by the time they are 18 year old. This pubertal spurt suggests that additional growth may be achieved by nutritional interventions during this period. If optimal nourishment is provided during the pre-pubertal growth spurt, girls are likely to undergo 'catch-up growth' and attain adult size comparable to better fed children. Consider the following information table giving information about eight adolescent regarding their food habits.

| Students | GroupI $(a_1)$ | Group II $(a_2)$ | GroupIII $(a_3)$ | GroupIV $(a_4)$ | Group V $(a_5)$ | Decision |
|---|---|---|---|---|---|---|
| $S_1$ | $\{V,M\}$ | $\{P,F\}$ | $\{P\}$ | $\{C,M\}$ | $\{P,F\}$ | Unhealthy |
| $S_2$ | $\{C,V,M$ | $\{C,P\}$ | $\{P,F\}$ | $\{C,P,M$ | $\{P,F\}$ | Healthy |
| $S_3$ | $\{C,M\}$ | $\{C,P,F\}$ | $\{F\}$ | $\{C,P,M$ | $\{F\}$ | Healthy |
| $S_4$ | $\{C,V,M$ | $\{C,F\}$ | $\{P,F\}$ | $\{P,M\}$ | $\{P,F\}$ | Unhealthy |
| $S_5$ | $\{C,V\}$ | $\{C,P,F\}$ | $\{P,F\}$ | $\{C,M\}$ | $\{P,F\}$ | Healthy |
| $S_6$ | $\{V,M\}$ | $\{C,P,F\}$ | $\{P,F\}$ | $\{C,P,M$ | $\{F\}$ | Healthy |
| $S_7$ | $\{V,M\}$ | $\{P,F\}$ | $\{P,F\}$ | $\{C,P\}$ | $\{P\}$ | Unhealthy |
| $S_8$ | $\{V,M\}$ | $\{C,P,F\}$ | $\{P,F\}$ | $\{C,P,M$ | $\{P,F\}$ | Healthy |

Table 3

A set valued ordered information system is presented in the above table, where U = { $S_1$, $S_2$, $S_3$, ….., $S_8$} and $A = \{a_1, a_2, a_3, a_4, a_5, d\}$, $a_1$ = GroupI, $a_2$ = GroupII, ….,$a_5$ = GroupV of the basic food groups and d is the decision as to whether a student is healthy or not. The attribute set A is divided into two classes- a class C, of condition attributes , namely, $a_1, a_2, a_3, a_4, a_5$ and a class D of decision attribute d. The set of attribute values is given by $V = \{C, P, F, V, M\}$ where C,P,F,V and M respectively stand for carbohydrate, protein, fat, vitamins, and minerals. From the table, $f(S_1, a_1) = \{V, M\}$ and $f(S_2, a_1) = \{C, V, M\}$ and hence $f(S_1, a_1) \subseteq f(S_2, a_1)$. Therefore, intake of fruits and vegetables by $S_2$ is much better than that by $S_1$. The family of dominance classes is given by

$$U_C^{\geq} = \{\{S_1, S_5, S_8\}, \{S_2\}, \{S_3\}, \{S_4\}, \{S_5\}, \{S_6\}, \{S_7, S_8\}, \{S_8\}\}.$$

**Case 1:** let $X = \{S_2, S_3, S_5, S_6, S_8\}$, the set of healthy students. Then the lower and upper approximations of X are given by $L_C^{\geq}(X) = \{S_2, S_3, S_5, S_6, S_8\}$, and $U_C^{\geq}(X) = \{S_1, S_2, S_3, S_5, S_6, S_7, S_8\}$ and hence the boundary region of X is $B_C^{\geq}(X) = \{S_1, S_7\}$. Then the corresponding nano topology with respect to X is given by $\tau_C^{\geq}(X) = \{U, \phi, \{S_2, S_3, S_5, S_6, S_8\}, \{S_1, S_2, S_3, S_5, S_6, S_7, S_8\}, \{S_1, S_7\}\}$. The basis of $\tau_C^{\geq}(X)$ is given by $\beta_C^{\geq}(X) = \{U, \{S_2, S_3, S_5, S_6, S_8\}, \{S_1, S_7\}\}$.

**Step 1:** Let $B_1 = C - \{a_1\}$. Then

$$U_{B_1}^{\geq} = \{\{S_1, S_5, S_8\}, \{S_2, S_8\}, \{S_3, S_6, S_8\}, \{S_4, S_8\}, \{S_5, S_8\}, \{S_6, S_8\}, \{S_7, S_8\}, \{S_8\}\}$$

and the corresponding nano topology is given by $\tau_{B_1}^{\geq}(X) = \{U, \phi, \{S_2, S_3, S_5, S_6, S_8\}, \{S_1, S_4, S_7\}\}$

Therefore, $\beta_{B_1}^{\geq}(X) \neq \beta_C^{\geq}(X)$.

If $B_2 = C - \{a_2\}$, then

$$U_{B_2}^{\geq} = \{\{S_1, S_2, S_5, S_8\}, \{S_2\}, \{S_2, S_3\}, \{S_2, S_4\}, \{S_2, S_5\}, \{S_2, S_6\}, \{S_2, S_7, S_8\}, \{S_2, S_8\}\}.$$

And $\tau_{B_2}^{\geq}(X) = \{U, \phi, \{S_2, S_3, S_5, S_6, S_8\}, \{S_1, S_4, S_7\}\}$.

Therefore, $\beta^{\geq}_{B_2}(X) \neq \beta^{\geq}_{C}(X)$. If $B_3 = C - \{a_3\}$, then $U^{\geq}_{B_3} = \{\{S_1, S_5, S_8\}, \{S_2\}, \{S_3\}, \{S_4\}, \{S_5\}, \{S_3, S_6\}, \{S_7, S_8\}, \{S_8\}\}$ and hence $\tau^{\geq}_{B_3}(X) = \{U, \phi, \{S_2, S_3, S_5, S_6, S_8\}, \{S_1, S_2, S_3, S_5, S_6, S_7, S_8\}, \{S_1, S_7\}\} = \tau^{\geq}_{C}(X)$ and hence $\beta^{\geq}_{B_3}(X) = \beta^{\geq}_{C}(X)$. If $B_4 = C - \{a_4\}$, then $U^{\geq}_{B_4} = \{\{S_1, S_5, S_8\}, \{S_2, S_5\}, \{S_3, S_5\}, \{S_4, S_5\}, \{S_5\}, \{S_5, S_6\}, \{S_5, S_7, S_8\}, \{S_5, S_8\}\}$ and hence the corresponding nano topology induced by $B_4$ is given by $\tau^{\geq}_{B_4}(X) = \{U, \phi, \{S_2, S_3, S_5, S_6, S_8\}, \{S_1, S_4, S_7\}\} \neq \tau^{\geq}_{C}(X)$ and therefore, $\beta^{\geq}_{B_4}(X) \neq \beta^{\geq}_{C}(X)$.

Similarly, when $B_5 = C - \{a_5\}$, then $U^{\geq}_{B_5} = \{\{S_1, S_5, S_8\}, \{S_2\}, \{S_3\}, \{S_4\}, \{S_5\}, \{S_6\}, \{S_7, S_8\}, \{S_8\}\} = U^{\geq}_{C}(X)$ and hence $\beta^{\geq}_{B_5}(X) = \beta^{\geq}_{C}(X)$. Therefore, $B_3$ and $B_5$ are the criterion reducts for S.

**Step 2:** Consider $B_3 = \{a_1, a_2, a_4, a_5\}$. Then $\beta^{\geq}_{B_3}(X) = \beta^{\geq}_{C}(X)$. Consider $B_3 - \{a_1\} = \{a_2, a_4, a_5\}$. Then $U^{\geq}_{B_{3-\{a1\}}} = \{\{S_1, S_5, S_8\}, \{S_2, S_8\}, \{S_3, S_6, S_8\}, \{S_4, S_8\}, \{S_5, S_8\}, \{S_3, S_6, S_8\}, \{S_7, S_8\}, \{S_8\}\}$ and $\tau^{\geq}_{B_{3-\{a1\}}}(X) = \{U, \phi, \{S_2, S_3, S_5, S_6, S_8\}, \{S_1, S_4, S_7\}\} \neq \tau^{\geq}_{C}(X)$

$Therefore, \beta^{\geq}_{B_{3-\{a_1\}}}(X) \neq \beta^{\geq}_{C}(X)$. Consider $B_3 - \{a_2\} = \{a_1, a_4, a_5\}$. Then $U^{\geq}_{B_{3-\{a_2\}}} = \{\{S_1, S_2, S_5, S_8\}, \{S_2\}, \{S_2, S_3\}, \{S_2, S_4\}, \{S_2, S_5\}, \{S_2, S_3, S_6\}, \{S_2, S_7, S_8\}, \{S_2, S_8\}\}$ and $\tau^{\geq}_{B_{3-\{a_2\}}}(X) = \{U, \phi, \{S_2, S_3, S_5, S_6, S_8\}, \{S_1, S_4, S_7\}\} \neq \tau^{\geq}_{C}(X)$.

Therefore, $\beta^{\geq}_{B_{3-\{a_2\}}}(X) \neq \beta^{\geq}_{C}(X)$.

Considering $B_3 - \{a_4\} = \{a_1, a_2, a_5\}$, we get $U^{\geq}_{B_{3-\{a_4\}}} = \{\{S_1, S_5, S_8\}, \{S_2, S_5\}, \{S_3, S_5\}, \{S_4, S_5\}, \{S_5\}, \{S_3, S_5, S_6\}, \{S_1, S_5, S_7, S_8\}, \{S_5, S_8\}\}$ and $\tau^{\geq}_{B_{3-\{a_4\}}}(X) = \{U, \phi, \{S_2, S_3, S_5, S_6, S_8\}, \{S_1, S_4, S_7\}\} \neq \tau^{\geq}_{C}(X)$. Therefore, $U^{\geq}_{B_{3-\{a_5\}}} = \{\{S_1, S_3, S_5, S_8\}, \{S_2, S_3\},$.

Similarly, $U^{\geq}_{B_{3-\{a_5\}}} = \{\{S_1, S_3, S_5, S_8\}, \{S_2, S_3\}, \{S_3\}, \{S_3, S_4\}, \{S_3, S_5\}, \{S_3, S_6\}, \{S_3, S_7, S_8\}, \{S_3, S_8\}\}$ and

$\tau^{\geq}_{B_{3-\{a_5\}}}(X) = \{U, \phi, \{S_2, S_3, S_5, S_6, S_8\}, \{S_1, S_4, S_7\}\} \neq \tau^{\geq}_{C}(X)$.

Therefore, $\beta^{\geq}_{B_{3-\{a_5\}}}(X) \neq \beta^{\geq}_{C}(X)$. Thus, $B_3$ is a criterion reduction of S.

**Step 3:** Consider $B_5 = \{a_1, a_2, a_3, a_4\}$. Then $\beta^{\geq}_{B_5}(X) = \beta^{\geq}_{C}(X)$. As in step2, when each of attributes in $B_5$ is removed from it, we find that $U^{\geq}_{B_{5-\{a_1\}}} = \{\{S_1, S_5, S_6, S_8\}, \{S_2, S_6, S_8\}, \{S_3, S_6, S_8\}, \{S_4, S_6, S_8\}, \{S_5, S_6, S_8\}, \{S_6, S_8\}, \{S_6, S_7, S_8\}, \{S_6, S_8\}\}$ and hence $\tau^{\geq}_{B_{5-\{a_1\}}}(X) = \{U, \phi, \{S_2, S_3, S_5, S_6, S_8\}, \{S_1, S_4, S_7\}\} \neq \tau^{\geq}_{C}(X)$. Therefore, $\beta^{\geq}_{B_{5-\{a_1\}}}(X) \neq \beta^{\geq}_{C}(X)$.

$U^{\geq}_{B_{5-\{a_2\}}} = \{\{S_1, S_2, S_5, S_8\}, \{S_2\}, \{S_2, S_3\}, \{S_2, S_4\}, \{S_2, S_5\}, \{S_2, S_6\}, \{S_2, S_7, S_8\}, \{S_2, S_8\}\}$

$\tau^{\geq}_{B_{5-\{a_2\}}}(X) = \{U, \phi, \{S_2, S_3, S_5, S_6, S_8\}, \{S_1, S_4, S_7\}\} \neq \tau^{\geq}_{C}(X)$

Therefore, $\beta^{\geq}_{B_{5-\{a_2\}}}(X) \neq \beta^{\geq}_{C}(X)$.

$\cup^{\geq}_{B_{5-\{a_3\}}} = \{\{S_1,S_3,S_5,S_8\},\{S_2,S_3\},\{S_3\},\{S_3,S_4\},$
$\{S_3,S_5\},\{S_3,S_6\},\{S_3,S_7\},\{S_3,S_8\}\}$
$\tau^{\geq}_{B_{5-\{a_3\}}}(X) = \{\cup,\phi,\{S_2,S_3,S_5,S_6,S_8\},$
$\{S_1,S_4,S_7\}\} \neq \tau^{\geq}_C(X)$.
Therefore,
$\beta^{\geq}_{B_{5-\{a_3\}}}(X) \neq \beta^{\geq}_C(X)$.
$\cup^{\geq}_{B_{5-\{a_4\}}} = \{\{S_1,S_5,S_7,S_8\},\{S_2,S_5\},\{S_3,S_5\},$
$\{S_4,S_5\},\{S_5\},\{S_5,S_6\},\{S_5,S_7,S_8\},\{S_5,S_8\}\}$
and
$\tau^{\geq}_{B_{5-\{a_4\}}}(X) = \{\cup,\phi,\{S_2,S_3,S_5,S_6,S_8\},$
$\{S_1,S_4,S_7\}\} \neq \tau^{\geq}_C(X)$. Therefore,
$\beta^{\geq}_{B_{5-\{a_4\}}}(X) \neq \beta^{\geq}_C(X)$.Thus,
$B_5 = \{a_1,a_2,a_3,a_4\}$ is another knowledge reduction of S.
Hence, **CORE(A)** = $B_3 \cap B_5 = \{a_1,a_2,a_4\}$

**Case 2**: Let $X = \{S_1,S_4,S_7\}$, the set of unhealthy students. Then
$\tau^{\geq}_C(X) = \{\cup,\phi,\{S_4\},\{S_1,S_4,S_7\},$
$\{S_1,S_7\}\}$ and hence
$\beta^{\geq}_C(X) = \{\cup,\{S_4\},\{S_1,S_7\}\}$

**Step 1:** $\tau^{\geq}_{B_1}(X) = \{\cup,\phi,\{S_1,S_4,S_7\}\}$ and
$\beta^{\geq}_{B_1}(X) = \{\cup,\{S_1,S_4,S_7\}\} \neq \beta^{\geq}_C(X)$.
$\tau^{\geq}_{B_2}(X) = \{\cup,\phi,\{S_1,S_4,S_7\}\} \neq \tau^{\geq}_C(X)$ and hence
$\beta^{\geq}_{B_2}(X) \neq \beta^{\geq}_C(X)$.
$\tau^{\geq}_{B_3}(X) = \{\cup,\phi,\{S_4\},\{S_1,S_4,S_7\},\{S_1,S_7\}\}$
and hence $\beta^{\geq}_{B_3}(X) = \beta^{\geq}_C(X)$.
$\tau^{\geq}_{B_4}(X) = \{\cup,\phi,\{S_1,S_4,S_7\}\}$ and hence
$\beta^{\geq}_{B_4}(X) \neq \beta^{\geq}_C(X)$.
$\tau^{\geq}_{B_5}(X) = \{\cup,\phi,\{S_4\},\{S_1,S_4,S_7\},\{S_1,S_7\}\}$
and hence $\beta^{\geq}_{B_5}(X) = \beta^{\geq}_C(X)$.

Thus, $B_3$ and $B_5$ are the knowledge reducts. As in case 1, we can show that these two reductions cannot further be reduced and hence they are the criterion reductions. Thus, **CORE (A)** = $B_3 \cap B_5 = \{a_1,a_2,a_4\}$.

**Observation:** From **CORE (A),** we conclude that Group I, Group II and Group IV **(vegetables and fruits; milk and milk products; pulses & cereals)** foods are the key food stuffs that provide the necessary nutrients for an adolescent girl to be healthy.

## IV. NUTRITION FOR CHILDREN

Nutrition is very important for everyone, but it is especially important for children because it is directly linked to all aspects of their growth and development. Another huge reason why nutrition is so important for children is because they simply don't know enough on their own to naturally choose to eat well. Unfortunately, the foods and snacks that taste the best are usually the worst for our bodies, and a child left to their own will almost always choose junk food over fruits and vegetables. Provide them with the right nutrition now and they will learn at an early age what's necessary for good health. This will also help to set them up for a life of proper eating and nutrition, almost certainly helping them to live longer.

Consider the following information table depicting the food habits of 6 children with the same notations as in the previous example.

| Children | GroupI $(a_1)$ | Group II $(a_2)$ | GroupIII $(a_3)$ | GroupIV $(a_4)$ | Group V $(a_5)$ | Decision |
|---|---|---|---|---|---|---|
| $C_1$ | $\{C,V,M\}$ | $\{C,P\}$ | $\{P,F\}$ | $\{C,P,M\}$ | $\{P,F\}$ | Healthy |
| $C_2$ | $\{C,V,M\}$ | $\{C,F\}$ | $\{P,F\}$ | $\{C,M\}$ | $\{F\}$ | Unhealthy |
| $C_3$ | $\{V,M\}$ | $\{C,P,F\}$ | $\{F\}$ | $\{C,P,M\}$ | $\{P,F\}$ | Unhealthy |
| $C_4$ | $\{C,M\}$ | $\{C,P,F\}$ | $\{P,F\}$ | $\{C,P,M\}$ | $\{P,F\}$ | Healthy |
| $C_5$ | $\{C,V,M\}$ | $\{C,P,F\}$ | $\{P\}$ | $\{C,P,M\}$ | $\{P,F\}$ | Healthy |
| $C_6$ | $\{C,V,M\}$ | $\{C,P,F\}$ | $\{P,F\}$ | $\{C,P\}$ | $\{F\}$ | Healthy |

Table 4

In the above table, the rows represent the set of six children and the columns represent the attributes - the basic five food groups. Let U= $\{C_1, C_2, C_6\}$ and A=$\{a_1, a_2, a_3, a_4, a_5, d\}$which is divided into two classes - a class C, of condition attributes $a_1$, $a_2$, $a_3$,

$a_4$, and $a_5$ and {d}, the decision attribute. The child $C_3$ is characterized by {($a_1$,{V,M}), ($a_2$,{C,P,F}), ($a_3$,{F}), ($a_4$,{C,P,M}), ($a_5$,{P,F}), (d, unhealthy)} which gives a complete picture of $C_3$. The family of dominance classes corresponding to C is given by $\cup_C^{\geq} = \{\{C_1\},\{C_2\},\{C_3\},\{C_4\},\{C_5\},\{C_6\}\}$. Let $X = \{C_1, C_4, C_5, C_6\}$, the set of healthy children.Then $L_C^{\geq}(X) = \{C_1, C_4, C_5, C_6\} = U_C^{\geq}(X)$ and hence $B_C^{\geq}(X) = \phi$. Therefore, the nano topology with respect to X is given by $\tau_C^{\geq}(X) = \{\cup, \phi, \{C_1, C_4, C_5, C_6\}\}$ and its basis, $\beta_C^{\geq}(X) = \{\cup, \{C_1, C_4, C_5, _6\}\}$.

**Step1**: Let $B_1 = C - \{a_1\}$. Then $U_{B_1}^{\geq} = \{\{C_1, C_4\},\{C_2, C_4\},\{C_3, C_4\},\{C_4\},\{C_4, C_5\},\{C_4, C_6\}\}$. Therefore, $L_{B_1}^{\geq} = \{C_1, C_4, C_5, C_6\}$, $U_{B_1}^{\geq}(X) = \cup$ and $B_{B_1}^{\geq}(X) = \{C_2, C_3\}$. Hence, $\tau_{B_1}^{\geq}(X) = \{\cup, \phi, \{C_1, C_4, C_5, C_6\},\{C_2, C_3\}\} \neq \tau_C^{\geq}(X)$ and hence $\beta_{B_1}^{\geq}(X) \neq \beta_C^{\geq}(X)$. Let $B_2 = C - \{a_2\}$. Then $\{C_1, C_6\}\}$ and hence $\tau_{B_2}^{\geq}(X) = \{U, \phi, \{C_1, C_4, C_5, C_6\},\{C_2, C_3\}\} \neq \tau_C^{\geq}(X)$.
Therefore $U_{B_2}^{\geq} = \{\{C_1\},\{C_1, C_2\},\{C_1, C_3\},\{C_1, C_4\},\{C_1, C_5\},$ $\beta_{B_2}^{\geq}(X) \neq \beta_C^{\geq}(X)$. Let $B_3 = C - \{a_3\}$. Then $U_{B_3}^{\geq} = \{\{C_1, C_5\},\{C_2, C_5\},\{C_3, C_5\},\{C_4, C_5\},\{C_5\},\{C_5, C_6\}\}$ and hence $\tau_{B_3}^{\geq}(X) = \{\cup, \phi, \{C_1, C_4, C_5, C_6\},\{C_2, C_3\}\} \neq \tau_C^{\geq}(X)$ Therefore, $\beta_{B_3}^{\geq}(X) \neq \beta_C^{\geq}(X)$. If $B_4 = C - \{a_4\}$, then $U_{B_4}^{\geq} = \{\{C_1\},\{C_2, C_6\},\{C_3\},\{C_4\},\{C_5\},\{C_6\}\}$. Therefore, $\tau_{B_4}^{\geq}(X) = \{\cup, \phi, \{C_1, C_4, C_5, C_6\},\{C_1, C_2, C_4, C_5, C_6\},\{C_2\}\} \neq \tau_C^{\geq}(X)$ and hence $\beta_{B_4}^{\geq}(X) \neq \beta_C^{\geq}(X)$.
Similarly taking $B_5 = C - \{a_5\}$, we see that $U_{B_5}^{\geq} = \{\{C_1\},\{C_2\},\{C_3\},\{C_4\},\{C_5\},\{C_6\}\} = U_C^{\geq}$ and hence $\beta_{B_5}^{\geq}(X) = \beta_C^{\geq}(X)$.

**Step 2:** Consider $B_5 = C - \{a_5\} = \{a_1, a_2, a_3, a_4\}$ for which $\beta_{B_5}^{\geq}(X) = \beta_C^{\geq}(X)$. Consider $B_5 - \{a_1\} = \{a_2, a_3, a_4\}$. $\cup_{B_5 - \{a_1\}}^{\geq} = \{\{C_1, C_4\},\{C_2, C_4\},\{C_3, C_4\},\{C_4\},\{C_4, C_5\},\{C_4, C_6\}\}$ and therefore $\tau_{B_5 - \{a_1\}}^{\geq}(X) = \{\cup, \phi, \{\{C_1, C_4, C_5, C_6\},\{C_2, C_3\}\} \neq \tau_C^{\geq}(X)$. Hence, $\beta_{B_5 - \{a_1\}}^{\geq}(X) \neq \beta_C^{\geq}(X)$. Consider $B_5 - \{a_2\} = \{a_1, a_3, a_4\}$.$\cup_{B_5 - \{a_2\}}^{\geq} = \{\{C_1\},\{C_1, C_2\},\{C_1, C_3\},\{C_1, C_4\},\{C_1, C_5\},\{C_1, C_6\}\}$ Therefore, $\tau_{B_5 - \{a_2\}}^{\geq}(X) = \{\cup, \phi, \{C_1, C_4, C_5, C_6\},\{C_2, C_3\}\} \neq \tau_C^{\geq}(X)$ and hence $\beta_{B_5 - \{a_2\}}^{\geq}(X) \neq \beta_C^{\geq}(X)$.
Considering $B_5 - \{a_3\}, U_{B_5 - \{a_3\}}^{\geq} = \{\{C_1, C_5\},\{C_2, C_5\},\{C_3, C_5\},\{C_4, C_5\},\{C_5\},\{C_5, C_6\}\}$ and $\tau_{B_5 - \{a_3\}}^{\geq}(X) = \{\cup, \phi, \{C_1, C_4, C_5, C_6\},\{C_2, C_3\}\} \neq \tau_C^{\geq}(X)$. Therefore, $\beta_{B_5 - \{a_3\}}^{\geq}(X) \neq \beta_C^{\geq}(X)$. Similarly $\cup_{B_5 - \{a_4\}}^{\geq} = \{\{C_1, C_6\},\{C_2, C_6\},\{C_3, C_6\},\{C_4, C_6\},\{C_5, C_6\},\{C_6\}\}$ and $\tau_{B_5 - \{a_5\}}^{\geq}(X) = \{\cup, \phi, \{C_1, C_4, C_5, C_6\},\{C_2, C_3\}\} \neq \tau_C^{\geq}(X)$.Therefore, $\beta_{B_5 - \{a_4\}}^{\geq}(X) \neq \beta_C^{\geq}(X)$.Thus, $B_5 = \{a_1, a_2, a_3, a_4\}$ is the knowledge reduction of S. Hence, $CORE(A) = \{a_1, a_2, a_3, a_4\}$.

**Observation:** From **CORE(A)**, we observe that Groups I,II,III and IV foods ( **vegetables and fruits; milk and milk products; meat, poultry and fish; pulses & cereals** ) are the key food groups that provide the necessary nutrients for a child to be healthy .

**Remark:** Following is the data on 'BALANCED DIET FOR CHILDREN' (Age between 4 and 9 years) taken from the literature on nutrition science.

| Basic food groups | Vegetarian | Non-vegetarian |
|---|---|---|
| | (gms.) | (gms.) |
| Cereals and pulses | 200 | 200 |
| Vegetables and Fruits | 100 | 100 |
| Milk and milk products | 250 | 200 |
| Meat, fish and eggs | - | 50 |
| Oil, ghee and butter | 25 | 25 |

Table 5

The above data is represented as a bar diagram as follows

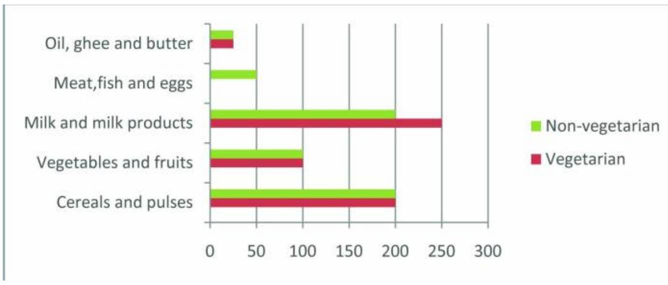


**Figure 2: Balanced Diet for Children**

## V. CONCLUSION

In this paper, we have applied set-valued ordered information systems in attribute reduction using the basis of nano topology in two real life situations. Normally, an adolescent girl is very conscious of her weight and structure and hence avoids food stuffs rich in fat. Here we have shown by means of topological reduction, that even if an adolescent girl avoids fat rich foods such as meat, poultry, fish, oil,ghee and butter, she can be healthy. But in the case of children between 4 and 9 years of age protein rich food is very necessary for their growth and therefore, vegetables and fruits; milk and milk products; meat, poultry and fish; pulses& cereals are very essential for them to be healthy. The amount of protein that a child even get from Group V may be balanced by the amount of protein they receive from other food groups. This is also clearly visible from the food pyramid as well as from the bar diagram. Thus, the basis of nano topology can be applied in nutrition science and in many real life situations.

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