



An analysis of the sources that provokes children towards junk food based on a novel accuracy function under interval-valued intuitionistic fuzzy environment

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Abstract

Food is the most indispensable part of our human life. Grains, Pulses, Fruits, Vegetables, Oils, etc., contain more amount of nutrients. But nowadays because our busy schedules, we consume food based on our comfort. We could not analyze if the food is either good or harmful to our health. A food with insufficient nutritional value is referred to as junk food. According to the recent studies, children are almost addicted to this junk food items because of cartoons and animations advertisement for unhealthy food habits. They conceive a curiosity among the children. These food items forge various diseases in their body both mentally and physically. Parents cannot steer them to avoid this processed food. These foods affect the children's healthy food habits. To isolate the desirable alternative in multicriteria decision-making problems, a novel accuracy function is introduced. Based on the novel accuracy function, a multicriteria fuzzy-decision making method is entrenched in which criterion values for alternatives are interval-valued intuitionistic fuzzy sets.

Keywords

Muticriteria fuzzy decision making, Aggregation operator, Interval-valued intuitionistic fuzzy set, Junk food, Children.

AMS Subject Classification

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1. Introduction

Decision making is a technique of accepting a specific discretion from multiple alternatives with the help of certain tools. In recent past, the application of the theory to muticriteria decision-making problems have been suggested by a great number of researchers.

A fuzzy set theory advanced by Lofti.A.Zadeh in 1965. The idea of intuitionistic fuzzy sets originated by Krassimir Atanassov in 1986, is an overview of the idea of fuzzy sets [1]. Later, Atanassov and Gargov innovated the idea of interval-valued intuitionistic fuzzy sets (IVIFSs), which is a abstraction of the idea of fuzzy sets (FSs) and (IFSs) [3]. In interval-valued intuitionistic fuzzy sets the degree of membership and the degree of non-membership are taken in the form of closed interval. Sometimes, in multicriteria decision-making prob-

lems we cannot get abundant knowledge about alternatives based on accuracy function and score function. For that, we need a novel accuracy function to choose our desirable alternative. A novel accuracy function helps us to deal with difficulties in our decision making especially, in current situation [15].

In this paper, we adopt an interval-valued intuitionistic fuzzy weighted arithmetic average operator, an accuracy of interval-valued intuitionistic fuzzy value with multicriteria fuzzy decision-making method. On the basis of the accuracy degree of the aggregated the interval-valued intuitionistic fuzzy information relating to the new accuracy function we apply the interval-valued intuitionistic fuzzy weighted arithmetic average operator to aggregate the interval-valued intuitionistic fuzzy information relating to every alternative and the rank all alternatives and chose the most acceptable one(s). This paper is structured as goes by: section 2 acquires basic definitions of interval-valued intuitionistic fuzzy sets, section 3 includes definition of novel accuracy function, section 4 contains the method depending on navel accuracy function, section 5 composes case study, section 6 holds problem illustration and suggested methodology for the problem of impacts of children towards junk food and finally, the conclusion is built.

2. Preliminaries

Definition 2.1. Let us take $X (\neq \emptyset)$ be a given set and $D[0, 1]$ be the set of all closed subintervals of the interval $[0, 1]$. Then an interval-valued intuitionistic fuzzy set A defined on X which is given by,

$$A = \{ \langle x, \mu_A(x), \nu_A(x) \rangle / x \in X \},$$

where $\mu_A : X \rightarrow D[0, 1]$, $\nu_A : X \rightarrow D[0, 1]$ satisfies the condition

$$0 \leq \sup(\mu_A(x)) + \sup(\nu_A(x)) \leq 1$$

for any $x \in X$. The degree of membership and non-membership of the element x to the set A are designated by the intervals $\mu_A(x)$ and $\nu_A(x)$ respectively. In such a way for every single $x \in X$, $\mu_A(x)$ and $\nu_A(x)$ are closed intervals and their lower and upper end points are, respectively, tagged by $\mu_{AL}(x)$, $\mu_{AU}(x)$, $\nu_{AL}(x)$, $\nu_{AU}(x)$. It is expressed by

$$A = \{ \langle x, [\mu_{AL}(x), \mu_{AU}(x)], [\nu_{AL}(x), \nu_{AU}(x)] \rangle / x \in X \}$$

where $0 \leq \mu_{AU}(x) + \nu_{AU}(x)$, $\mu_{AL}(x) \geq 0$, $\nu_{AL}(x) \geq 0$.

Definition 2.2. The hesitancy degree (or) the degree of indeterminacy of an intuitionistic fuzzy interval of $x \in X$ in A which is elucidated as

$$\begin{aligned} \pi_A(x) &= 1 - \mu_A(x) - \nu_A(x) \\ &= [1 - \mu_{AU}(x) - \nu_{AU}(x), 1 - \mu_{AL}(x) - \nu_{AL}(x)] \end{aligned}$$

Definition 2.3. Let $A_j (j = 1, 2, \dots, n) \in IVIFS(X)$. The weighted arithmetic average operator which is represented by

$$\begin{aligned} F_W(A_1, A_2, \dots, A_n) &= \sum_{j=1}^n W_j A_j \\ &= \left(\left[1 - \prod_{j=1}^n (1 - \mu_{A_j L}(x))^{W_j}, \right. \right. \\ &\quad \left. \left. 1 - \prod_{j=1}^n (1 - \mu_{A_j U}(x))^{W_j} \right], \right. \\ &\quad \left. \left[\prod_{j=1}^n \nu_{A_j L}(x)^{W_j}, \prod_{j=1}^n \nu_{A_j U}(x)^{W_j} \right] \right), \end{aligned} \tag{2.1}$$

where W_j is the weight of $A_j (j = 1, 2, \dots, n)$, $W_j \in [0, 1]$ and $\sum_{j=1}^n W_j = 1$.

Notably, suppose $W_j = 1/n (j = 1, 2, \dots, n)$, and so F_W is called an arithmetic average operator for IVIFS.

Definition 2.4. Let $A_j (j = 1, 2, \dots, n) \in IVIFS(X)$. The weighted geometric average operator which is represented by

$$\begin{aligned} G_W(A_1, A_2, \dots, A_n) &= \prod_{j=1}^n A_j^{W_j} \\ &= \left(\left[\prod_{j=1}^n \mu_{A_j L}(x)^{W_j}, \prod_{j=1}^n \mu_{A_j U}(x)^{W_j} \right], \right. \\ &\quad \left[1 - \prod_{j=1}^n (1 - \nu_{A_j L}(x))^{W_j}, \right. \\ &\quad \left. \left. \prod_{j=1}^n (1 - \nu_{A_j U}(x))^{W_j} \right] \right), \end{aligned} \tag{2.2}$$

where W_j is the weight of $A_j (j = 1, 2, \dots, n)$, $W_j \in [0, 1]$ and $\sum_{j=1}^n W_j = 1$.

Notably, suppose $W_j = 1/n (j = 1, 2, \dots, n)$, and so G_W is called a geometric average operator for the IVIFS.

Definition 2.5. An interval-valued intuitionistic fuzzy number A can be written as $A = ([a, b], [c, d])$. Then an accuracy function H of an interval-valued intuitionistic fuzzy value can be described as

$$H(A) = \frac{a + b + c + d}{2} \text{ where } H(A) \in [0, 1] \tag{2.3}$$

3. Novel accuracy function

An interval-valued intuitionistic fuzzy number A can be written as $A = ([a, b], [c, d])$. Then a novel accuracy function M of an interval-valued intuitionistic fuzzy value constructed on the indefinite degree is determined by the subsequent formula:

$$\begin{aligned} M(A) &= \frac{a - (1 - a - c) + b - (1 - b - d)}{2} \\ &= a + b - 1 + \frac{c + d}{2} \end{aligned} \tag{3.1}$$

where $M(A) \in [-1, 1]$.



4. Multicriteria fuzzy decision-making method depended on novel accuracy function

In this segment, we declare a conducting method for multicriteria fuzzy decision-making problems with weights.

Let us take $A = \{A_1, A_2, \dots, A_n\}$ be a set of alternatives. Consider that $C = \{C_1, C_2, \dots, C_n\}$ as a set of criteria. Speculate that the weight of the criterion $C_j (j = 1, 2, \dots, n)$, enrolled by the decision-maker, is $W_j, W_j \in [0, 1]$ and $\sum_{j=1}^n W_j = 1$. In this state, the component of each alternative A_i is described by an IVIFS :

$$A_i = \{ \langle C_j, [\mu_{A_i L}(C_j), \mu_{A_i U}(C_j)], [v_{A_i L}(C_j), v_{A_i U}(C_j)] \rangle \}_{C_j \in C}$$

where $0 \leq \mu_{A_i U}(C_j) + v_{A_i U}(C_j) \leq 1, \mu_{A_i L}(C_j) \geq 0, v_{A_i L}(C_j) \geq 0, j = 1, 2, \dots, n$ and $i = 1, 2, \dots, m$. The value of an interval-valued intuitionistic fuzzy set which can be taken in the form of intervals $\mu_{A_i}(C_j) = [a_{ij}, b_{ij}], v_{A_i}(C_j) = [c_{ij}, d_{ij}]$ for each $C_j \in C$ is expressed by $\alpha_{ij} = ([a_{ij}, b_{ij}], [c_{ij}, d_{ij}])$, where $[a_{ij}, b_{ij}]$ implies the degree that the alternative A_i convinces the criterion C_j allowing by the decision maker, $[c_{ij}, d_{ij}]$ implies the degree that the alternative A_i does not convinces the criterion C_j allowing by the decision maker, $[a_{ij}, b_{ij}] \subset [c_{ij}, d_{ij}] \subset [0, 1]$.

Hence, we can obtain a decision matrix $D = (\alpha_{ij})_{m \times n}$. In consonance with each row in the decision matrix, by using equation (2.1) and (2.2) we can defined an aggregating interval-valued intuitionistic fuzzy number α_i for $A_i (i = 1, 2, \dots, m)$ is

$$\alpha_i = ([a_i, b_i], [c_i, d_i]) = F_{iW}(\alpha_{i1}, \dots, \alpha_{in})$$

or

$$\alpha_i = ([a_i, b_i], [c_i, d_i]) = G_{iW}(\alpha_{i1}, \dots, \alpha_{in}).$$

Among the four alternative we need to choose our desirable alternative. For that, by using equation (3.1) we have to compute the accuracy $M(\alpha_i)$ of the interval-valued intuitionistic fuzzy value $\alpha_i (i = 1, 2, \dots, m)$ to rank the alternative $A_i (i = 1, 2, \dots, m)$.

The procedure for the handling method can be generalized as follows:

Step: 1

Compute the weighted arithmetic average values by utilizing equation (2.1) if we point out the group's influence, or else compute the weighted geometric average values by utilizing equation (2.2).

Step: 2

Compute the accuracy $M(\alpha_i)$ of interval-valued intuitionistic fuzzy value $\alpha_i (i = 1, 2, \dots, m)$ by utilizing equation (3.1).

Step: 3

Rank the alternative $A_i (i = 1, 2, \dots, m)$ and elect the desirable one(s) in agreement with $M(\alpha_i) (i = 1, 2, \dots, m)$.

5. Influences of junk food on children

In our lifetimes, Food is the most requisite necessity for nutrition. Basically, our human body requires a mixture of the succeeding five nutrients-proteins, carbohydrates, fat, vitamins, minerals. These nutrients make our body healthy and also give energy to survive. Good nutrition are always gained from eating traditional foods and healthy foods. But nowadays, nutritious foods have been replenished novel food mantra-Junk food! According to the recent trends, we know that the junk food is fast, delicious, comfortable and trendsetting for all over the world. The colors of the junk food cause various diseases and are poisonous to the body. Junk food is the one which affects children both physiologically and psychologically. Junk food has been associated to contemplative health problems which include heart disease, obesity, bone and joint problems, sleep apnea, lack of energy and focus, nutrient deficiency, respiratory diseases, peptic ulcers, diabetes asthma and eczema [14, 22]. In psychology, it includes behavioral and emotional problems, anxiety and depression and memory issues [13]. Basically children are innocuous and inexperienced. Chocolates, ice-cream, pastries, burgers, chips, French fries and coke are the junk food items children like to eat [21]. Based on analysis, especially in India children as a leading intension market for food and beverage industry. A new research has shown that the children's eating models are mainly influenced by their own parents, peers, television advertisements and supermarkets.

Junk food influences children through parents:

Most of the children consider their parents as the basic role model in the society. The learning process starts from their parents. Children revolve around the parents for support, role-player, fixing rules for distinct activities. So they are easily influenced by the parents eating models. Nowadays, parents have no comfort because of their busy schedule, so they accommodation foods for their families. Accommodate foods contain processed and packaged products, Junk food and restaurant fare [10]. Most of the parents encourage their children by making the junk food items as a main incentive for school records or any competition programs [12]. Parents should not give more money to their children because they do not know how to spend money in the food items. A new research shows that at the time of pregnancy, the intake of junk food by mothers can affect the children's mental health and behavioral problems [18].

Junk food influences children through peers:

In the time of schooling children can be eloquently influenced by their peers. At school during the lunch time, if one child prefers the junk food items in their group then definitely all the other children follow that eating models [11]. This is the age group of children who imitate the other characters, they could not analyse whether it is good or bad to them. A study proclaimed in child development presented that preschool-aged children can be easily influenced by the peer's eating



models. Exactly, when one child buys a chocolate with offered gifts or toys, it creates curiosity among other children, and they also want to boast off among them.

Junk food influences children through television advertisements:

Television is fixed as superior entrance for advertising food items. Advertisements are a fundamental trimmer. Children are very influenced by advertisements. In India, the food advertising endorses sugary cereals, junk food and beverages and additional items which consist of higher amount of sugar, sodium, calories, fat and lower in nutrients. Studies have shown that children are along with revealed to the cartoon characters and the food items affirmed by these cartoon characters that may lead children to the unhealthy food items. Celebrity endorsements also support junk food advertising. Children those who admire celebrities wish to buy that food item [9].

Junk food influences children through supermarkets:

Based on new research, as a result from the university of Sheffield, children are more exhibited to high calorie junk food items like chocolates, chips, ice-creams, soft drinks pastries and other packaged foods because of preference supermarkets [19]. Parents could not control their children because they are very interested to purchase their likely food items in a shopping trolley. Research has evidenced that, in supermarkets parents are dominated by children’s pester power [20].

6. Problem description

In recent trends, junk food becomes eating patterns of every people. Especially children were attached to this unhealthy food items. There are four alternatives which affect the children eating habits according to four criteria. In the interval-valued intuitionistic fuzzy decision matrix, the degree of membership and the degree of non-membership of every alternative $A_j(j = 1, 2, \dots, m)$ together with the criteria $C_j(j = 1, 2, \dots, n)$ that can be taken in the form of closed interval which is given by the decision maker. The weight of the criterion also made by the decision maker. According to the data acquisition we can select our acceptable alternative by using multicriteria fuzzy decision-making method under interval-valued intuitionistic fuzzy information.

6.1 Methodology

By manipulating the interval-valued intuitionistic fuzzy information which is given by the decision maker based on four criteria (Attractiveness, Creates curiosity, Trendy attitude, Addicted to tastier), we can estimate the four alternatives (Parent’s preferences, Peers group, Television advertising, Supermarkets). The decision matrix that is relented by the decision maker which is manifested below:

$$\begin{bmatrix} ([0.4, 0.6], [0.2, 0.3]) & ([0.6, 0.7], [0.1, 0.3]) & ([0.8, 0.9], [0.0, 0.1]) & ([0.7, 0.8], [0.1, 0.2]) \\ ([0.7, 0.6], [0.1, 0.2]) & ([0.8, 0.9], [0.0, 0.1]) & ([0.7, 0.8], [0.1, 0.2]) & ([0.2, 0.4], [0.3, 0.5]) \\ ([0.8, 0.9], [0.0, 0.1]) & ([0.8, 0.9], [0.0, 0.1]) & ([0.7, 0.8], [0.1, 0.2]) & ([0.6, 0.7], [0.1, 0.3]) \\ ([0.6, 0.7], [0.1, 0.3]) & ([0.5, 0.6], [0.2, 0.3]) & ([0.8, 0.9], [0.0, 0.1]) & ([0.5, 0.6], [0.2, 0.3]) \end{bmatrix}$$

Let us speculate that the weights of $C_1, C_2, C_3,$ and C_4 are 0.3, 0.2, 0.3, 0.2 subsequently.

Step: 1

By applying equation (2.1), the weighted arithmetic average value α_i for A_i are determined as follows,

$$\begin{aligned} \alpha_1 &= ([0.6536, 0.7831], [0, 0.1990]) \\ \alpha_2 &= ([0.6634, 0.7329], [0, 0.2091]) \\ \alpha_3 &= ([0.7406, 0.8466], [0, 0.1534]) \\ \alpha_4 &= ([0.6447, 0.7579], [0, 0.2158]) \end{aligned}$$

Step: 2

We can calculate $M(\alpha_i)(i = 1, 2, \dots, 4)$ by using equation (3.1),

$$\begin{aligned} M(\alpha_1) &= 0.5362 \\ M(\alpha_2) &= 0.5009 \\ M(\alpha_3) &= 0.6639 \\ M(\alpha_4) &= 0.5105 \end{aligned}$$

Step: 3

Depended on the accuracy degrees of $M(\alpha_i)(i = 1, 2, \dots, 4)$, we should rank the alternatives $A_3 > A_1 > A_4 > A_2$ and pick up the most agreeable one. Hence the most acceptable alternative is A_3 .

7. Conclusion

In our society, Junk food has developed into a system of generation. In several families, junk food is considered as a regular food item. Especially children mainly incited by their surroundings either directly or indirectly which lead them to take junk food items. We must save our future generation without any junk food affecting critical health glitches. The recommended paper is very articulate and also helpful to deal with multicriteria fuzzy decision-making method. At the end the whole perception of this paper, we conclude that Television advertising is the most acceptable alternative. So, if they advertise fruits, vegetables and healthy food items instead of junk food items then the children will also observe and follow them because the cartoon characters, animations, toys, gifts easily intrigues children. Television food advertising should advertise dissipation of fruits and vegetables. A study has shown that in our country, the city which has taken the first position in cancer is Chennai and Delhi is in second position [16, 17].

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