An alternative operationalization of fuzzy consideration set. Application to tourism

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Abstract—*Consideration sets provide a standard tool for the exploration of consumer choice. It is appropriate to analyze it as a fuzzy set because not all the brands of a certain category of products or services that belong to it are considered of the same importance.*

In this work we propose an alternative operationalization of the aggregate fuzzy consideration set. It is based on a new approach for linguistic framework and linguistic aggregation operators which compute with words directly, defined by Xu. The model of consideration presented assigns to each brand or service the degree of membership to the evoked set through weighed aggregate interest.

The aggregate fuzzy consideration set of tourist destinations of a given of individuals segment is obtained as illustrative example of the proposed approach.

Keywords— aggregation operators, computing with words, fuzzy consideration set, linguistic model, tourist destinations.

1 Introduction

Several variables take place in the study of the consumer's behaviour, which is a complex activity. To face it in a more suitable manner, flexible models are appropriate; these will consider the uncertainty implied by its treatment, particularly those using the theory of the fuzzy sets. This theory provides an important background for the representation of preferences and the uncertainty contained in decision making. This approach can be applied to the analysis of the consideration set or evoked set.

Though the individual has a certain number of possibilities to choose among, it is possible that he does not take into account all the available alternatives. These alternatives considered during the decision making form what is known as the *consideration set* or *evoked set*.

The consideration set is a subset of all alternatives available for the consumer in a category of products or services. It is made up by his preferred brands, with which he is acquainted, those he remembers and those he positively evaluates for purchasing and consumption [1, 2].

Howard [3] was the first to introduce the term evoked set in the literature of marketing to talk collectively about the set of brands that the consumer considers in his process of purchases decision. Several authors elaborated this concept later [4, 5, 6].

Consideration sets have been the subject of much research since 1986. The level of interest in this study can be attributed to several factors [7]. Among others, a consideration set represents a task-simplifying heuristic that consumers use to cope with complex choice problems [8]; models that ignore consideration set information may have biased parameter estimates [9] and when a brand enters the consideration set of a consumer, the chances that the consumer will choose that brand increase even if it is not the most preferred. Its exclusion prevents the selection of the brand even if it is likely to be preferred [10].

Lilien *et al.* [9] states that studying the composition of the consideration set is important for two reasons: the first one because it will help the company that does not belong to the set to know its own lacks and the characteristics of those companies or brands that belong to it; the second because it is an important part of the general study of the consumption processes. Some research have shown that to include the consideration set in the stages of decision model allows to obtain better prognoses and a more suitable handling of diagnoses [11].

Fotheringham [12] suggests that the consideration set is not binary, but it might be treated as a fuzzy set, maybe because the consideration is not a discreet process of the consumers or because the investigators are not capable of measuring it. He expresses that not all the brands taken into account in the phases of evaluation and election are given the same importance.

In previous works [13, 14] we have developed a linguistic model to obtain the membership function of the aggregate fuzzy consideration set, for a category of products or services, by means of the usual linguistic framework and linguistic aggregation operators based on the Extension Principle [15, 16, 17, 18].

In this paper an alternative linguistic model is proposed, to obtain the aggregate fuzzy consideration set which is based on a new approach for linguistic framework and on the linguistic weighted arithmetic averaging (LWAA) operator, which enables to compute with words directly, defined by Xu [18, 19, 20, 21].

Then, this methodology is applied to obtain the aggregate fuzzy consideration set of tourist destinations (TDs) of the young, with the data obtained in a survey carried out on students of the University of Buenos Aires.

The cardinality of the evoked set and its support is obtained, in order to find its magnitudes. Besides, a measure of fuzziness is calculated to know the entropy that affects the fuzzy consideration set.

The paper is organized as follows. In Section 2 we introduce a linguistic framework presented by Xu [18, 20] to define some linguistic aggregation operators and the LWAA operator definition. In Section 3 we give an alternative operationalization of the aggregate fuzzy consideration set.

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In Section 4 the aggregate fuzzy consideration set of TDs is obtained and in Section 5 some concluding remarks are pointed out.

2 Fuzzy linguistic approach

The fuzzy linguistic approach is an appropriate technique to deal with qualitative aspects of problems [22].

Following Xu [18, 19, 20, 21] we consider a finite and totally ordered label set $S=\{s_\alpha/\alpha=-t,...,-1,0,1,...,t\}$, which cardinality value is odd, and t is a positive integer. Each term s_α represents a possible value for a linguistic variable [18, 19, 20, 21] and it must have the following characteristics:

i) $s_\alpha > s_\beta$ iff $\alpha > \beta$.

ii) There is the negation operator: $\text{neg}(s_\alpha)=s_{-\alpha}$; mainly $\text{neg}(s_0)=s_0$.

The mid linguistic label s_0 represents an assessment of "indifference" and the rest of labels are defined around it symmetrically.

To preserve all the given information, Xu [18, 19] extended the discrete linguistic label set S to a continuous linguistic label set $\overline{S}=\{s_\alpha/\alpha\in[-q,q]\}$, where q $(q>t)$ is a sufficiently large positive integer.

If $s_\alpha \in S$, then s_α is called an original linguistic label, otherwise, s_α is called a virtual linguistic label. Generally, the decision maker uses the original linguistic terms to evaluate attributes and alternatives, and the virtual linguistic labels can only appear in calculations [20, 21].

Considering any two linguistic terms $s_\alpha, s_\beta \in \overline{S}$, and $\lambda\in[0,1]$, Xu [19] introduces two operational laws of linguistic variables as follows:

- $s_\alpha \oplus s_\beta = s_\beta \oplus s_\alpha = s_{\alpha+\beta}$. (1)
- $\lambda . s_\alpha = s_{\lambda\alpha}$. (2)

Based on (1) and (2) Xu [18, 19, 21] developed various linguistic aggregation operators, which compute with words directly.

In this section we present the linguistic weighted arithmetic averaging (LWAA) operator due to the fact that it will be the linguistic operator used in our aggregate fuzzy consideration sets model.

Definition [18]: Let $LWAA: \overline{S}^n \to \overline{S}$. If

$$LWAA_w(s_{\alpha_1}, s_{\alpha_2}, ..., s_{\alpha_n}) = w_1 s_{\alpha_1} \oplus w_2 s_{\alpha_2} \oplus ... \oplus w_n s_{\alpha_n} = s_{\overline{\alpha}} \quad (3)$$

Where $\overline{\alpha}=\sum_{j=1}^{n} w_j.\alpha_j$, $w=(w_1, w_2, ..., w_n)$ is the weight vector of the linguistic label s_{α_j}, $j=1,...,n$, $w_j\in[0,1]$ and $\sum_{j=1}^{n} w_j = 1$, then *LWAA* is called the linguistic weighted arithmetic averaging operator.

The fundamental aspect of the *LWAA* operator is that it computes the linguistic labels taking into account the importance of the information [18].

3 The fuzzy consideration set

3.1 Preliminaries

When forming the evoked set of a certain category of products or services, the consumers do not show the same interest in their purchase, due to the variety of attributes these products or services have and to other factors that in most cases are subjective, thus, it is appropriate to analyze it as a fuzzy set [7, 9, 12, 13, 14].

When developing its model of consideration, Fotheringham [12] states that the evoked set can be considered fuzzy because uncertainty about its composition exists. Although the author affirms that the consideration sets are fuzzy, his formulation does not derive from the theory of the fuzzy sets. Besides, it does not explain which the fuzziness source is or how it obtains the membership function.

Wu and Rangaswamy [7] developed a model of consideration and election, which they call fuzzy. His work suggests that a fuzzy approach is useful to represent the fuzziness of the consideration set, their model is derived from probability theory and they do not explain how to obtain the membership function.

The model of consideration presented in this paper assigns to each brand or service the degree of membership to the evoked set through weighed aggregate interest, calculated by means of the *LWAA* operator. To obtain the value of the membership function of a brand or service, the aggregate degree of interest is weighed in agreement with the quantity of individuals who chose the above mentioned brand or service.

3.2 Building aggregate fuzzy consideration sets

Surveys to potential clients interested in the purchase of a type of goods or services are made to obtain the aggregate fuzzy consideration set of a category of products or services of a given of individuals segment. In the questionnaire we ask about:

- The names of the well-known brands.
- The names of the brands that they would consider buying.
- The degree of interest with which these are considered for their purchase.

For the design of questionnaires for the surveys a set of linguistic labels is chosen which fulfils the characteristics given in 2., so that the consulted individuals express their degree of interest in the purchase of the goods or the services.

First of all, the referential set of the evoked set (E) is obtained with the brands that appear in the survey. It is named set of well-known brands or awareness set.

To obtain the value of the membership function of each element the aggregate fuzzy consideration set, the following steps are involved:

Step 1. *The aggregate degree of interest.* If m is the quantity of proposed brands in the surveys and n is the cardinality of the label set S, the aggregate degree of interest

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(q_i) of each brand or service (c_i) considered is obtained by means of the application of (1).

$$q_i = LWAA_{c_i}\left(s_{\alpha_1}, s_{\alpha_2}, \ldots, s_{\alpha_n}\right) = s_{\overline{\alpha}_i} \quad i = 1,\ldots, m \qquad (4)$$

Where $\overline{\alpha}_i = \sum_{j=1}^{n} w_j \alpha_j$ and the weighting vector of the linguistic level s_{α_j} is $w = (w_1, w_2, \ldots, w_n)$. If r_{ij} is the quantity of individuals that selected the brand or service c_i with the level s_{α_j} and v_i is the quantity of all individuals that selected this brand, then:

$$w_j = \frac{r_{ij}}{v_i}, j = 1,\ldots, n;\ w_j \in [0,1],\ \sum_{j=1}^{n} w_j = 1 \qquad (5)$$

Step 2. *The value of the membership function, without weighing:* We define it on the basis of the aggregate degree of interest, displacing the scale of order $\frac{n-1}{2}$, later standardized.

$$\kappa_i = \frac{2\overline{\alpha}_i + n - 1}{2(n-1)}, \quad i = 1,\ldots, m,\ 0 \le \kappa_i \le 1 \qquad (6)$$

Step 3. *The weighting vector*: $p = (p_1, \ldots, p_m)$ is obtained to reflect the number of times each brand is chosen in the survey. Specifically, weights p_i are calculated as follows:

$$p_i = \frac{F_i}{\max F_i};\ 0 < p_i \le 1; \forall i = 1,\ldots, m \qquad (7)$$

where F_i is the frequency of occurrence for each brand.

Step 4. *The aggregate fuzzy consideration set*: The value of the membership function for each brand or service (c_i) is calculated as follows:

$$\mu_C(c_i) = p_i . \kappa_i \qquad (8)$$

which represent the intentions of purchase of the individuals selecting the brand or service c_i.

Finally, the aggregate fuzzy consideration set is:

$$C: E \to [0,1] / \mu_C(c_i) = p_i . \kappa_i \qquad (9)$$

4 Application

In this section, the aggregate fuzzy consideration set of TDs of a given of individuals segment is obtained as an illustrative example of the proposed approach.

The consideration set of TDs is a subset of the set of all consumers' available alternatives and it is constituted by those TDs with which the consumer is acquainted, which he remembers or which he considers would be interesting to visit, and which were evaluated positively to spend his holidays [23, 24].

As not all the TDs taken into account in the phases of evaluation and election are considered to have the same importance, it is possible to state that they belong to the evoked set with a different degree [13, 14]. For this reason we propose to treat the consideration set of TDs as a fuzzy set on the basis of the set of the places known by the consumers.

Since mid 1900s, tourism has turned into one of the economic activities of major growth in the world. The tourist activity mobilises public and private funds, affecting the economic and social conditions of the population, and it can be an essential tool to achieve a sustainable development as it is a generator of employment and currency. This justifies the systematical study of the tourist activity in a region or country.

Young tourism is an increasing world trend. The characteristic of this segment is the performing of trips, different from those of the traditional market. In Argentina, the young tourism represents almost 20 % of the tourist entire market.

Then, the methodology presented in Section 3.2 is applied to obtain the aggregate fuzzy consideration set of TDs of young students, with the data obtained in a survey.

A random closed survey to 940 students of the University of Buenos Aires (UBA) between 19 and 29 years of age was done in September 2008. We obtained information about the tourist places that students would like to visit in the next summer vacation (January, February, 2009) and the degree of interest to visit particular locations.

A linguistic term set of five values was used, and every student expressed his degree of interest in each TD considered by one of this label of the set S.

$S = \{ s_{-2} = \text{very low (VL)},\ s_{-1} = \text{low (L)},\ s_0 = \text{middle (M)},\ s_1 = \text{high (H)},\ s_2 = \text{very high (VH)} \}$

The data obtained in the survey were processed. The TDs of the support of aggregate fuzzy consideration set are:

$c_1 = \text{Bariloche}$
$c_2 = \text{Cataratas del Iguazú}$
$c_3 = \text{Córdoba}$
$c_4 = \text{El Calafate}$
$c_5 = \text{Jujuy}$
$c_6 = \text{Mar del Plata}$
$c_7 = \text{Mendoza}$
$c_8 = \text{Pinamar}$
$c_9 = \text{Puerto Madryn}$
$c_{10} = \text{Salta}$
$c_{11} = \text{San Martín de los Andes}$
$c_{12} = \text{Ushuaia}$

As an example of the calculation of the value of the membership function, we will obtain it for $c_1 = \text{Bariloche}$.

Step 1: We assume $s_{\alpha_1} = s_{-2}$; $s_{\alpha_2} = s_{-1}$; $s_{\alpha_3} = s_0$; $s_{\alpha_4} = s_1$; $s_{\alpha_5} = s_2$.

By (4) and (5), we have $w = (\frac{2}{273}, \frac{9}{273}, \frac{59}{273}, \frac{103}{273}, \frac{100}{273})$, thus,

$$\overline{\alpha}_1 = \frac{2}{273} \times (-2) \oplus \frac{9}{273} \times (-1) \oplus \frac{59}{273} \times 0 \oplus \frac{103}{273} \times 1 \oplus \frac{100}{273} \times 2$$

therefore, $\overline{\alpha}_1 = 1.06$ and $q_1 = s_{1.06}$.

Step 2: By means of (6) $\kappa_1 = \frac{2(1.06) + 4}{8} = 0.77$.

Step 3: Using (7) $p_1 = \frac{273}{306} = 0.89$.

Step 4: Finally, $\mu(c_1) = 0.69$.

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The following results are contained in Table 1.

In column 1: The TDs of the support of aggregate fuzzy consideration set.

In column 2: The frequency of each TD (F_i).

In column 3: The aggregate degree of interest of each TD (q_i).

In column 4: The value of membership function of each TD, without weighing (κ_i).

In column 5: The weight of each TD (p_i).

In column 6: The value of membership function of each TD ($\mu(c_i)$).

Table 1: Results of 1st survey - UBA 2008

TDs	F_i	q_i	κ_i	p_i	$\mu(c_i)$
c_1	273	$s_{1.06}$	0.77	0.89	0.69
c_2	306	$s_{0.97}$	0.74	1	0.74
c_3	231	$s_{0.78}$	0.70	0.75	0.53
c_4	152	$s_{1.43}$	0.86	0.50	0.43
c_5	161	$s_{1.07}$	0.77	0.53	0.41
c_6	182	$s_{0.45}$	0.61	0.59	0.36
c_7	247	$s_{1.02}$	0.75	0.81	0.61
c_8	100	$s_{0.67}$	0.67	0.33	0.22
c_9	91	$s_{1.09}$	0.77	0.30	0.23
c_{10}	269	$s_{1.12}$	0.78	0.88	0.69
c_{11}	91	$s_{1.24}$	0.81	0.30	0.24
c_{12}	162	$s_{1.29}$	0.82	0.53	0.43

It is possible to express the linguistic aggregate degree of interest (LADI) of each TD using a label of set S. Approximating the subindex of the virtual label to an integer value by means of the usual round operation, i.e., round $(\overline{\alpha}_i)$. The results can be observed in Table 2. This information is useful to the decision maker.

Table 2: Linguistic aggregate degree of interest

TD	q_i	$s_\alpha \in S$	LADI
c_1	$\alpha_{1.06}$	α_1	High
c_2	$\alpha_{0.97}$	α_1	High
c_3	$\alpha_{0.78}$	α_1	High
c_4	$\alpha_{1.43}$	α_1	High
c_5	$\alpha_{1.07}$	α_1	High
c_6	$\alpha_{0.45}$	α_0	Middle
c_7	$\alpha_{1.02}$	α_1	High
c_8	$\alpha_{0.67}$	α_1	High
c_9	$\alpha_{1.09}$	α_1	High
c_{10}	$\alpha_{1.12}$	α_1	High
c_{11}	$\alpha_{1.24}$	α_1	High
c_{12}	$\alpha_{1.29}$	α_1	High

The destinations that belong to the aggregate fuzzy consideration set have obtained high levels of aggregate interest, except for Mar del Plata which obtained middle level. The predominant destinations are "Cataratas del Iguazú", "Salta" and "Bariloche", with the biggest values of membership (Table 1).

To have an idea of the magnitude of the obtained sets, their cardinality has been calculated.

Awareness set: $|E| = 62$.

Support of aggregate fuzzy consideration set: $|S(C)| = 12$.

Aggregate fuzzy consideration set: $\|C\| = 5.22$.

To determine the degree of uncertainty contained in the information provided by the aggregate fuzzy consideration set, we obtained the Yager's measure of fuzziness [25].

$$e_Y(C) = 1 - \frac{\left[\sum_{i=1}^{n} \left|\mu_C(x_i) - \mu_{\overline{C}}(x_i)\right|^p\right]^{\frac{1}{p}}}{|\mathrm{supp}(C)|}, \; p \in N - \{0\} \qquad (10)$$

$0 \le e_Y(C) \le 1$.

If $p = 1$, then $e_Y(C) = 0.68$.

We can states that the fuzziness of the obtained set is moderate. This value indicates a measure of the information quality about the uncertainty of the group's consideration.

The utility of the entropy has its roots in the possibility of comparison as well as in the study of fuzziness' evolution existing in a system.

Empirical available evidence of similar studies shows that the fuzziness of the aggregated fuzzy consideration set is moderate in the first instance of its evaluation and diminishes its value as you approach the moment to make the decision about your holidays.

Reference [14] shows that if $p = 1$, then (10) is equal to Kaufmann's linear index of fuzziness.

5 Conclusions

This paper offers a new approach to build aggregate fuzzy consideration set.

We verified that it enables to find more easily results similar to those obtained with the method that uses linguistic operators based on the Extension Principle.

The operator used in the model presented compute with words directly and weighs the linguistic argument itself, instead of the ordered position. It allows for a continuous representation of the linguistic information on its domain, and thus, they can represent any counting of information obtained in an aggregation process without any loss of information.

In this work we have presented preliminary results of a research on young tourism begun in 2008. In this project we will analyze young people behaviour in choosing a TD in Argentina. National University population will be the aim of this study, since attending students have heterogeneous characteristics.

With the information obtained through longitudinal exploratory studies, we will determine and analyze the aggregate fuzzy consideration sets of tourist destinations in Argentina at local and regional level, in winter and summer. We will study the dynamics and the fuzziness of the aggregate sets and the attributes the young have in mind when choosing possible destinations to spend their vacations. Obtained results will be compared considering tourist season and geographic areas.

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Finally, after each vacation period, the same group of students will be asked about which TD was visited, to check the forecast of the model.

This study will allow us to obtain relevant information, to make a diagnosis of the situation of the young tourism in the considered regions and to plan actions tending to increase this activity.

At this stage of the research we obtained and analyzed the aggregated awareness sets and consideration set of tourist destinations of Argentina for the young people in 2009 summer vacation.

The results allow to infer that the hypothesis referred to consideration set's fuzziness is valid as the consulted young people stated that not all the TDs considered to spend their next vacation have aroused the same interest of visit.

We observed that the destinations considered are traditional and well-known. They are distributed all around the whole country and present a variety of sceneries and attractions, such as the sea, the mountains, lakes, glaciers, rivers, waterfalls and cities with great cultural activity.

The favorites TDs are Bariloche, Mar del Plata, Iguazú Waterfalls and Córdoba, because they present the largest degree of consideration.

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