ALGORITHMS FOR RANKING GOODS FOR ELECTRONIC TRADE

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Annotation*: We consider the problem of ranking goods traded in e-commerce. Proposed vector parametric display of consumer demand with using a fuzzy logic model. Ranging is carried out on the basis of the evaluation of component-by-component local correspondence of the properties of the goods to a given demand. Received matches are aggregated using the OWA statement and fuzzy logical quantifiers. A numerical example is considered ranking.*

Keywords: *e-commerce, fuzzy predicates, fuzzy quantifiers, aggregation operators.*

INTRODUCTION AND PROBLEM STATEMENT

In the analysis and synthesis of socio-economic systems a significant role is played by a reasonable choice of active elements systems of such system components and characteristics that form the state of the system, effective, from the point of view of active decision-making element [1]. In particular, in electronic commerce (electronic trading platforms, online stores) an important role is played by filters that define the boundaries of consumer properties of goods and providing the buyer with a narrowing of the total set of goods to a significantly smaller group of alternative goods [2]. The filter is a computer program which, referring to the database of the disposable collection of goods, presented as an EAV model, based on logical operations checks which entities satisfy the filter conditions. Model entity-attribute-value (EAV), is the data model for coding in a space-efficient way of entities, where the number of attributes (properties, parameters) that can be used to describe them is potentially large, but the number that will actually apply to a given entity is elatively small.

However, the presented classical approach to the formation filters can no longer fully meet the needs buyers [3], since it has a number of disadvantages, of which the following should be noted. First of all, filtering based on binary logic is unable to ensure the ranking of the set alternatives with conflicting vector characteristics; the solution of a non-trivial vector optimization problem is required. In addition, the binary logic used does not have sufficient expressiveness in describing the desired customer needs [4,5]. An approach that eliminates these shortcomings, the use of comparative component-by-component analysis can serve compliance (matching) of consumer demand and offered goods based on infinite-valued (fuzzy) logic and use of aggregation operators of the received component-by-component correspondence [6]. In this case, infinite-valued logic provides the required expressiveness of consumer demand and guarantees the location of the presented goods on the ranking scale. Article is devoted to the description of the main algorithms for applying logic

fuzzy propositions and predicates for ranking types homogeneous product in the e-commerce market.

1. Algorithms for assessing the conformity of goods to consumer demand

The development of consumer demand models requires the introduction of ecommerce market of a single product catalog. Such the requirement is not unique. Product catalog unification today is regarded as a national task, [7]. We we assume that for each homogeneous product within a single catalog has its own view of the EAV model, in vector form. Let there be some homogeneous product represented by a set of their interchangeable types, differing values of the characteristic parameters (attributes) of this product.

Description of each j-th sample (type) of goods, j = 1; 2; ...; J we will represent the values of the characteristic parameters, describing commercial, technical and other possible properties goods. These parameters are conveniently represented by the corresponding vector:

$$q_j = (q_j^1; \dots; q_j^n; \dots; q_j^N) \quad (1)$$

Each n -th component of which takes the values x on either quantitative or qualitative scale.

We will assume that each k -th buyer, k = 1; 2; ...; K wants purchase a homogeneous product with desired values characteristic parameters. It is only natural that desires buyer will be vague. In this case the buyer has a choice, which is determined by interchangeability of types of homogeneous goods. For this, the buyer it is necessary to formalize your desires and capabilities in the form of a vector demand with "impersonal", fuzzy characteristics of a homogeneous goods:

$$\tilde{g}_k = (\tilde{g}_k^1; \dots; \tilde{g}_k^n; \dots; \tilde{g}_k^N) \quad (2)$$

The vector components here are linguistic variables with names that match the names of the corresponding characteristic parameters for describing the type of a homogeneous product. Each variable has piecewise linear membership functions f_g (x), whose carriers are – $x_{\min} \leq x \leq x_{\max}$ reflect the possibilities choice of the consumer, and the value of the function - the level of his preference (desires). or discrete support values, the function accessories will look like a table. Fuzzy characteristic parameters form a model of individual consumer demand.

Let everyone i -th seller, i = 1; 2; ...; I, who entered the ETP, formulates proposals for j-th type of a homogeneous product in the form vector:

$$q_{ij} = (q_{ij}^1; \ldots; q_{ij}^n; \ldots; q_{ij}^N) \quad (3)$$

with clear values of characteristic parameters, structurally identical to the demand vector. In general, the proposal represented by some set of vectors q_{ij}, $j = 1, 2, \ldots, J_i$ Evaluation of local (component-by-component) conformity of goods individual consumer demand is performed by substitution values of the vector components (3) in the membership function of the components vector (2). The resulting value of the membership function considered as a local correspondence between supply and demand according to specified component.

To obtain a generalized correspondence, it is necessary aggregate local correspondences using one or another aggregation operator [8]. By aggregation we mean transition from a vector estimate of the dimension ***n*** to a scalar quantity

$$agr : \bigcup_{n=1}^{N} [0;1]^n \to [0;1] \quad (4)$$

The most general approach to aggregating information is in the axiomatic definition of the aggregation operator. Wherein three main strategies can be distinguished [9]: conjunctive (the generalized estimate cannot be better than the worst of the local ratings); disjunctive (the generalized estimate is determined by the best of local estimates) and compromise (generalized estimate takes intermediate position between the values of local estimates, participating in the aggregation).

We will consider the class of averages satisfying the condition [10]

$$agr(x_1; x_2; \ldots; x_n) \in [\min(x_1; x_2; \ldots; x_n); \max(x_1; x_2; \ldots; x_n)] \quad (5)$$

A feature of averages is the presence of weights $w = (w_1; w_1; \ldots; w_n)$ which take into account the "contribution" of each particular assessment to generalized sessment, while the weight reflects the significance relevant source of information (criteria, indicator, attribute). In cases where the importance of values is primary private estimates, the weighted ordinal operators are applied aggregation [11] – OWA operators that aggregate components vector evaluation, ordered in a certain way:

$$OWA(x_1; x_2; \ldots; x_n) = \sum_{j=1}^{n} w_j x_{\sigma(j)}, \quad (6)$$

Where σ - ordering index by item level $x_{\sigma(1)} \le x_{\sigma(2)} \le \ldots \le x_{\sigma(n)}$

Assume that all criteria have from the point of view of the consumer the same importance. Then the rule for assigning weights can be defined following expression

$$w_j = Q\left(\frac{j}{n}\right) - Q\left(\frac{j-1}{n}\right) \quad (7)$$

Where Q is the given type of fuzzy quantifier. A fuzzy quantifier is a fuzzy a statement about the acceptable form of compromise between valuations j x reflecting the intuition of the decision maker (DM) on the preference of solutions [12]. A fuzzy statement is given by the membership function *Q(n)* - $Q(\frac{j}{n})$, where r- is interpreted as the proportion of estimates obtained for which the property described by the membership function is satisfied quantifier. For example, if the quantifier is given Q = r , which interpreted as "for as many as possible", then the weights for four alternatives will be given in accordance with (7) as follows way: $w_1 = 0,25$; $w_2 = 0,25$; $w_3 = 0,25$; $w_4 = 0,25$;

That is, the quantifier Q = r defines a special case of the operator OWA is the arithmetic mean.

2. Numerical testing of conformity assessment algorithms

Let the buyer want to rank two types of homogeneous goods, characterized by the following clear values parameters given by vectors:

$(q_1^1 = 2; q_2^1 = 25; q_3^1 = 0{,}8)$ *and* $(q_1^2 = 3; q_2^2 = 20; q_3^2 = 0{,}7)$

Relevant Buyer Needs displayed as fuzzy values with functions accessories:

$f_1(q) = 1{,}5 - 0.25q;\ \ f_2(q) = 3 - 0{,}1q;\ \ f_3(q) = q;$

Correspondence of characteristic parameters of product types the needs of the buyer is calculated by substituting the values components of vectors into the corresponding membership functions. AT result vector matching, S each type of product needs can be represented by two vectors: $S_1 = (1; 0{,}5; 0{,}8)$ *and* $S_2 = (0{,}75; 1; 0{,}7)$

To rank goods, that is, to find out which of them better meets the needs of the buyer, we will use the OWA aggregation operator with the calculation of weights using the "for the majority" quantifier given by the following function accessories

$$Q(n) = \begin{cases} 0, & if\ r \le 0{,}4 \\ 2{,}5r - 1, & if\ 0{,}4 < r < 0{,}8 \\ 1, & if\ 0{,}8 \le r \le 1 \end{cases}$$

The ordered match vectors will take the form:

$S_1 = (0{,}5; 0{,}8; 1)$ *and* $S_2 = (0{,}7; 0{,}75; 1)$

Note that the weight w_j not associated with a specific vector element matching, but with its order in the ordered vector.

With a given quantifier *Q(r)* and in accordance with (7) the weights take values:

$w_1 = 0$; $w_2 = 0{,}65$; $w_3 = 0{,}33$;

Then the aggregate correspondence of product types is calculated in the following way:

$$S_1 = QWA(x) = 0 \cdot 0{,}5 + 0{,}65 \cdot 0{,}8 + 0{,}33 \cdot 1 = 0{,}85;$$

$$S_2 = QWA(x) = 0 \cdot 0{,}7 + 0{,}65 \cdot 0{,}75 + 0{,}33 \cdot 1 = 0{,}82;$$

The result obtained indicates that the first type of product slightly better than the second.

CONCLUSION

Various filtration methods currently in use when organizing the search for goods that meet the needs buyers, allow you to select from the totality of goods, a subset of goods with vector characteristics, satisfying the filtration conditions. Received subset contains goods with acceptable characteristics, but is missing possibility of their comparison. The proposed approach is essential expands search capabilities. It allows you to specify preferences buyer, formalizing them in the form of linguistic variables, which provides a numerical representation of matches for individual characteristic parameters of goods. Further aggregation local matches to global ones, allows you to rank valid subset of goods resulting from filtration, providing the customer with decision support when choice of goods.

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