A New Method for Complex Goods Selection in Electronic Markets

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***Abstract*—**After the development of the Internet a suitable discipline for trading goods electronically has been emerged. However, this type of markets is not still mature enough in order to become independent and get closer to seller/buyer's needs. Furthermore, the buyable and sellable goods in these markets still don't have essential standards for being well-defined. In this paper, we will present a model for development of a market which can contain goods with variable definitions and we will also investigate its characteristics. Besides, by noticing the fact that people have different discriminations, it's figured out that the significance of each attribute of a specific product may vary from different people's view points. Consequently we'll present a model for weighting and accordingly different people's view points could be satisfied. These two aspects will be discussed completely throughout this paper.

***Keywords*—**Electronic markets, selection of multi attribute goods, data infusion.

I. Introduction

After the development of the Internet a suitable discipline for trading goods electronically has been emerged which has attracted numerous researcher to this field who have developed many automatic markets. However, this type of markets is not still mature enough in order to become independent and get closer to seller/buyer's needs. Furthermore, the buyable and sellable goods in these markets still don't have essential standards for being well-defined. This problem had arisen because different goods may have different attributes and from any individual's point of view some attributes may be more important than the others. Development of markets which are capable of including goods with variable attributes has always been one of the issues which have attracted researcher's attention. On the other hand, by noticing the fact that people have different discriminations, it's figured out that the significance of each attribute of a specific product may vary from different people's view points. Development of a suitable model that can provide the desired product regarding to the people's discriminations provides another field of research for researchers. In this paper, alternatives for both aspects are proposed.

The rest of this paper is organized as follows:

In next chapter we briefly review some relevant works. Then we present a new method to distinguish attributes of goods. After that we propose a way to describe structure of products in a general form. In section V and VI we review a way for storing and searching goods. In next section we describe a method for scoring the results. Finally we conclude the work in section VIII.

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II. Related Works

The works that had been done in this field in electronic markets can be divided into three categories including works that has been performed in the field of combinatorial auctions, works that are devoted to discuss how to define complex goods and works that investigate the way to trade complex work. Then important works in these three disciplines will be posed and each will be described briefly.

A. Combinatorial Markets

Researchers have implemented appropriate systems for buying and selling combinatorial goods which can buy and sell a set of goods simultaneously. Reference [1] Indicates the fact that buyer may accept to pay different prices for buying combination of goods, a precise analysis of this type of markets is represented and needed concepts for combinatorial prices with high speed search power are investigated. In [2] and [3] other concepts are investigated which are more concerned about finding an optimized or semi-optimized case and they also provided a linear solution for that. References [4], [5] and [6] also survey markets in which numerous buys are performed simultaneously. References [7] and [8] also discuss branch and bound methods for processing buy request and linear algorithms for their implementation. References [9] and [10] investigate a system to search for an appropriate case in a market containing complex goods and they provide a fast solution for finding an optimized case too. In [11] Firstly, indicates a framework for market, then it provides a method for finding an appropriate case in the market.

B. Express Complex Goods

New methods for indicating the way to express complex goods and concepts like price assignment of goods from quantity and quality are provided, in all of which the way to express complex goods are desired. Reference [12] lets the buyer determine a relationship between price and quantity of purchased goods. Reference [13] discusses the relationship between quantity and price of goods and after showing that finding the best case is a non-linear problem it provides a greedy solution. Reference [14] also surveys markets based on negotiation for a product's different attributes. Reference [15] indicates a simple and effective method for determination of quality based on price.

C. Buy and Sell Complex Goods

Most researchers focused their work on how to buy complex goods in continues double auctions. Reference [16] provides a market for buying and selling complex goods which works reasonable for up to one thousand requests. Reference [17] surveys a technique for keeping buy requests of complex goods and generating relationship between them. Reference [18] illustrates a model for buying and selling complex goods which let buyer and seller define their desired goods and the market determines their similar case.

III. Attributes Determination

Structures introduced for determination of products' attributes mostly contain a number of specified attributes which should be filled by the buyer and then market with regard to those attributes searches for the product satisfying them. In this method for each product there exists a special form which should be filled with that product's specific attributes.

A. Categorization of Different Attributes

If we look at the structure of buy request generally, structure of these forms usually can be divided into three general categories;

Common attributes, specified attributes and description attributes.

1. Common attributes

The first category of attributes includes common attributes which usually exist in all goods and are not limited to a special group of goods. Attributes like type of product, model of product, color of product, production date and price are instances of attributes which are common in all products.

2. Specified attributes

The second category includes those attributes which deal with a specific type or model of a product and that are related to a specific set of goods. For instance, for buying a vehicle attributes like distance gone by the vehicle, being new/second-hand, being manual/automatic, number of doors the vehicle has can be considered as the attributes for the selection of a vehicle.

3. Descriptive attributes

The third category contains the attributes which are not existed in the other two categories for some reasons. One of such reasons can be that these attributes may only be desired by some special buyers in which other buyers may not be interested or they may not have sufficient knowledge about those attributes. For instance, in order to buy a vehicle many buyers may not be interested in knowing that if the position of the cylinder in engine is linear or v-shape, or if the size of the back and front rings are larger/smaller than the normal size. Another reason of these attributes for being special is that they are various models available for a special product. For instance, the ability to configure the height of the vehicle or the ability to move on three rings or the ability to use the hydrogen fuel in the vehicle can be applied to a few models.

B. Necessary Vs. Preferable Attributes

Another aspect of buy request should also be considered. Meaning that, attributes that are desired by the buyer would be divided into two general categories. The first category includes those attributes that if not satisfied the buyer would reject the whole buying process. These attributes are referred to as main and necessary attributes. The second category contain those attributes that if not included won't cause the buyer to reject the buying process. For instance, a buyer may wish to buy a vehicle with automatic gear, otherwise he/she would reject to buy or a buyer may prefer to buy a vehicle which is either black or white and if none of which were available the color of the vehicle won't matter anymore.

C. Satisfaction Rate of Attributes

Another important criterion is that to what extend the buyer would accept to change the attributes she has specified. In other words, buyer should have the option to specify the way system interacts with goods which are roughly similar to her defined goods under a short expression like "majority of attributes" or "some attributes".

D. Specifying the Rate of Proportional Importance of Each Attribute

Generally, all the attributes for which the buyer specifies value have the same weight from the system side. For instance, there's no preference between color and model of a vehicle but in reality it's not the case from the buyer's point of view. Form the buyer point of view the model of the vehicle may be considered as an important aspect whereas the color of the vehicle doesn't matter. Therefore; in order to be able to set the buyer's priorities in the weighting system, the buyer should be capable of preferring some attributes to the others if desired. The buyer should have the ability of modifying the general state of the attributes which is the same for all the attributes, and change the weight of the attributes she/he wants to.

IV. Structure of Buy Request

By noticing the attributes which were previously defined, initially buy request has a first section which is the same for all goods existing in the market and should be filled by the buyer. In the next stage, after determining type and model of the product the buyer can see the second section of the attributes which is related to the product's specific model and in the end there exists a section referred to as the name of attributes under which the buyer would fill out the attributes that he/she wishes to have and are not specified in the first nor the second section of the buy request.

On the other side, seller would fill all three sections on the seller part. In this case, the third section contains the descriptions that seller wants to add which don't exist in the general descriptions of the market by default. Actually they are additional descriptions for defining the product more precisely. Therefore, the seller can add any desired descriptions about a specific product in the market which he/she thinks are necessary.

A. Model Specification and Representation

The descriptions inserted into the searching system of market through the user interface include a number of attributes including their corresponding values, their specified weights determined by the buyer's choice and a general description for determining the degree of similarity of search result to the described product. In addition to these, it also specifies if each attribute is absolutely significant or the attribute is only preferred by the buyer. The general form of the model which presents the buy request to the searching system is as followed:

$$R = function(A_1, A_2, ..., A_n)$$

Where R indicates the buy request and is a function of described attributes. Term *function* illustrates to what extend the described product is similar to products shown as search results. It is actually the fuzzy function which is determined under the simple expression like "majority of attributes" or "some attributes" specified by the buyer. The attributes which exist in the buy request are shown by A_1 to A_n indicating the 1^{st} attribute to n^{th} attribute respectively. Each attribute has following formula:

$$A_i = (V_1, V_2, ..., V_n [,?]) * W_i$$

Where V_1 is first preferred value and V_2 is second preferred value and so on. W_i is indicating the Weight associated to attribute A_i. For the attribute A_i, the preferred values specified by the buyer are ordered from the value with highest priority to the value with the lowest priority separated by coma. If the buyer doesn't ascertain that the specified values are the only accepted values by her/him for buying a specific product then a question mark would be added at the end of the list meaning that the attribute can have the values not indicated in the list. If there was no question mark as the last element of the list and none of the preferred values matches the goods being searched, then no goods would be shown as the result to the buyer even if the rest of the attributes completely match the buyer's request. Finally, if the buyer has specified a weight, it would be shown as a multiplying factor of that attribute which is an expression indicating how important the attribute is and can have the values like "*insignificant*", "*normal*" or "*significant*". If this is not specified, the value "*normal*" will be set as the attribute's weight.

B. Explaining an Instance

Referring to car buying case, the general form of the market system transfers the buy request to a model, the set sequence of A_1= (*Black*, *White*, *?*) indicates that preferable values of attribute A_1 (which is color in this case) is black as the most preferred color. The second most preferred color is white. If none of which was available it won't matter. The numerical set sequence A_2 = (*>2000*, *=2000*, *>1995*) is another example of various attributes which the buyer can specify. This set verifies the production date. Meaning that the buyer wishes to buy a vehicle produced after the year 2000 as his first choice, as his second choice he wants a vehicle which is produced in the year 2000 and as the last choice he wants to buy a vehicle produced between 1995 and 2000. Consequently, he won't accept to buy a vehicle which is produced before 1995. In this example, if the buyer sets the extent of significance of attribute A_1 to "*insignificant*" and he doesn't determine any specific weight for the other attributes (which in turn would automatically be set to "*normal*"), then it can be concluded that the color of the vehicle has the least significance compared to other attributes. The given values to the attributes can be of type string or integer. In the case where the values are integers they can be set to be more than, less than or equal to a constant value. If the attributes are of type string, they can have constant values of type string.

V. Storing Available Goods

After specifying how to illustrate the buy request in the system, the way to keep the available goods should be discussed. Therefore, they can be matched with buy request that has the same structure and the same attributes specified by the buyer

A. Model Specification and Storage Method

For storing the information related to goods existing in the market a hierarchical structure should be considered. The attributes related to the products which reside in the market to be sold (unlike the buy request) each can only have one value. Each attribute is stored in a level of the tree corresponding to that specific attribute. Initially the public attributes starting from the type and model of the product would be inserted into the tree, after that the private attributes would be added which can have different names regarding to their type and model. The leaves are actually the result of product description by public and private attributes including price attribute (which is a public attribute) and explanation attribute (which is one of the descriptive attributes). Therefore, every branch is terminated by a number of leaves indicating those products which had the same attributes except the price and explanation attributes. Even though the price attribute belongs to the first category of attributes, it is stored in explanations because it has a wide range of values and refers to a specific product conceptually and is like a summary of other attributes. It is stored as the last element in the description section.

B. Explaining an Instance

Assume that the car buying case has the attributes; type of product, model of product, production date, color and price as public attributes. In addition to the type of gearbox as the only private attribute. Fig. 1 illustrates nine vehicles indexed in the tree structure. In order to add a new product in the tree, initially the corresponding product's type and product's model branches are chosen. Then the public attributes and after that the private attributes of corresponding branches are chosen in alphabetic order. Finally, a leaf would be added for price and description of that product.

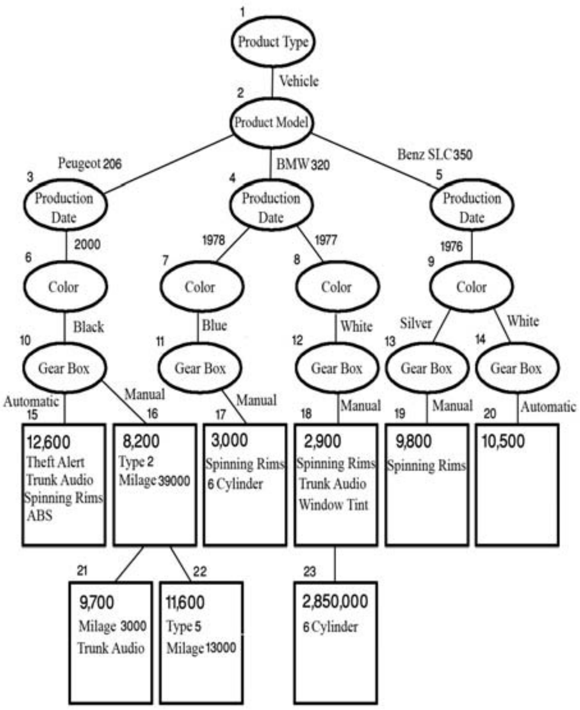

Fig. 1 Tree structure for selling vehicle in the market

The root of the tree is always the product's type followed by the product's model. In the lower levels of the tree there exist the description and the price which are divided into two categories of public and private. They are organized alphabetically. If at any level of the tree corresponding values for the product's attributes are not found, new branches will be created for the rest of attributes in alphabetic order which would consequently store values of the product's attributes. When a product is deleted form the tree and there exists no other value for any attribute of that product then the whole branch would be removed from the tree.

VI. How to Search the Goods in the Market

After determining the way to store the goods in the market, it's time to illustrate how to search the tree for the given request. This can be done regarding to the description inserted in the buy request.

A. Search Method Explanation

In searching the tree, in each level the inserted values for that specific attribute is compared to the values stored in the tree. If any acceptable value corresponding to buyer's request is found all other sub-branches of that branch should be searched as well. If question mark is also one of the elements of an attribute indicated by the buyer, all sub-branches of that attribute should be searched.

B. The Method to Search Integers

For searching the numerical attributes which can include the operators >, < and =, the values which satisfy the given condition are chosen to be searched. For instance, in the tree shown in fig. 1, if all the values in higher levels are chosen and production date attribute can only accept values more than 1977 (as buyer has requested) then the branches 7 and 8 are chosen to be searched.

C. The Method to Search Strings

In searching the attributes having the string type the only acceptable values are constant values. For instance, in fig. 1, if all the values in the higher levels of the tree are selected and the color attribute can only accept the value 'white' (as buyer has requested) then the branches 12 and 14 would be expanded to be searched.

D. The Method to Search Descriptions

When the search gets to the description section and the price attribute of the product matches the price attribute of the buy request, then the description section of the product and the description section of the buy request would be searched in order to find similar words and expressions. The number of similar cases would be considered in the scoring system.

VII. Scoring Search Results

When the search section indicates an attribute fits the acceptable values, then its turn to score that specific attribute of the available product in the market. Scoring should be performed for all the attribute of the product that has all coinciding attributes.

A. Scoring Each Attribute

Each attribute in the tree generally is scored as descried in the following:

If the i^{th} preference of the set containing n preferred values of the customer is adjusted, this preference will have the score $(n+1-i)/(n+1)$. For instance, if the first preference of the customer is adjusted (where $i=1$), the score of this attribute will be set to 1 which is the maximum score. If the attribute is adjusted to the last preference of the customer (where $i=n$), the attribute will get the value $1/n+1$ which is the minimum value. If a request contains a question mark as its last element which can be adjusted to any attribute, it will be considered as the last preference of the customer and it will get the value $1/n+1$. For descriptive attributes, in its simplest form, the number of the scores they will get depends on the ratio of the adjusted expressions or words to the total number of expressions or words.

B. Weighting based on Weights Specified by the Buyer

After scoring each attribute based on the method described previously, in order to consider the buyer's preferences as well, the weight indicated by the buyer (in the buy request for each attribute) should be multiplied in the scoring result. Therefore, weights of the attributes which are considered to be more significant from buyer's view point would have higher range of variation. Consequently, the goods which match different values for significant attributes are more distributed from goods which match different values for insignificant attributes in scoring space. For transferring the weight to its corresponding numerical value, a diagram like the one shown in Fig. 2 can be used. As shown in this figure, different levels of significance have their own numerical values illustrated on the curve. The shape of the curve may vary for each buyer.

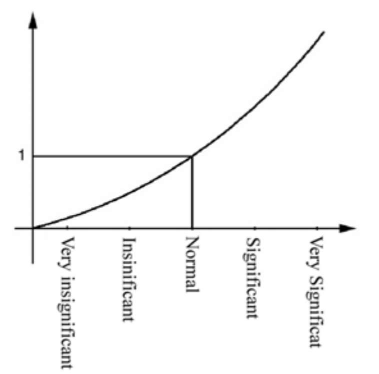

Fig. 2 Diagram for transferring weight to numerical value

C. OWA Weighting on all Attributes

This stage is specified so that high-scored attributes can not recover low-scored attributes. More precisely, the attributes which have gained their weights with lower variation compared to the attributes which have gained their weights with higher variation should be preferred. For this purpose, firstly all the scores should be ordered from the highest to the lowest. Then the lowest would be multiplied in the n^{th} score, the next one would be multiplied in the $(n-1)^{th}$ score etc. The highest score would be multiplied in 1 resulting in goods with lower variation gaining higher scores.

D. Weighting based on the Expressions

As the last stage (after indicating weight of each attribute based on the explained methods) the extent to which the specified product is similar to buy request should be indicated by a general function. For this purpose, the attributes would be arranged in decreasing order, because the high-scored attributes are more adjusted to buy request and they are more critical in decision-making. Then after, each attribute would be multiplied in its corresponding weight specified in the given function. Two instances of these functions would be described in the following.

1. "Some attributes" expression

This expression indicates that when a number of attributes have been adjusted, the rest of the attributes are not significant anymore. Namely, fitting a few attributes suffices for the customer. The result is shown in fig. 3. In this figure, the initial attributes are more significant. The significance of the attributes would decrease gradually when the number of attributes increases. The curve would start with the value 1 and get closer to the horizontal axes (the value 0) gradually. The gradient of the curve can be changed based on the buyer's interpretation of the determined expression.

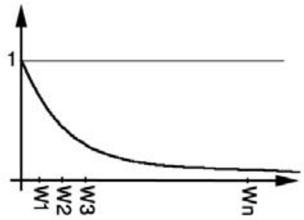

Fig. 3 Diagram for transferring the "Some attributes" expression to numerical value

2. "Majority of attributes" expression

Under this expression, unlike the previous one, the buyer indicates that he/she wants more attributes to be adjusted and adjusting just a few attributes doesn't suffice. Fig. 4 illustrates this fact. From buyer's view point, the initial fitted attributes are not very significant. The more attributes adjusted, the more the buyer would be satisfied. This diagram starts from the value 0 and gradually gets closers to the value 1. The gradient of the curve can also be changed based on the buyer's interpretation of the expressions 'few' and 'plenty'.

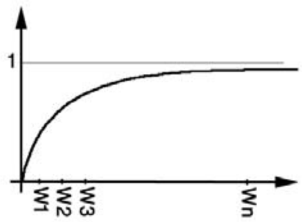

Fig. 4 Diagram for transferring the "Majority of attributes" expression to numerical value

VIII. Conclusion

In this paper, we initially represented the similar works done in this respect. After that we have divided the attribute types into three various and general categories which is one of the most important aspects in describing the goods. Then we have presented a solution for showing how the buyer can indicate the significance of an attribute in the market. In addition to that, we illustrated the structure of a buy request, the way to present it and the way to store it. After that the way to search the various defined attributes has explained. Finally, a number of appropriate methods have been determined for scoring the chosen products. The issues which can be identified as the future works are improvement of the scoring system and the way to adjust the descriptive attributes with information recycling methods. In future, new methods should be provided for these areas.

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