Decision Support System using Analytic Hierarchy Process(AHP) on Multiagent System

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Abstract

Electronic commerce (e-commerce) has changed the outlook of traditional business trading behavior. E-commerce includes different types of activities related to the online sales of goods and services. In this paper, decision support system for customer based on buyer's preferences by using Analytic Hierarchy Process (AHP) displaying total score based on Multi-Agent system is presented. The system cooperate the top products nearly the same of user preferences and focus on decision making for multi-buyer and the multi-seller can participate by uploading theirs products. Moreover, the bargaining strategy helps both buyers and sellers to get satisfaction in their designation. As a case study, a Java Web Application which is developed in Tomcat and Internet Explorer is used.

1. Introduction

Decision Support Systems (DSS) are type of information system whose principle objective is to support a human decision maker during the process of arriving at a decision.DSS have more analytical power than other systems. They are built explicitly with a variety of models to analyze data or they condense large amounts of data into a form where decision makers can analyze them. [1]

E-commerce is the buying and selling of goods and services on the Internet. Web based selling systems are Internet based shopping systems for selling and buying products, information and services. The concept of agents is today very popular and the term has been applied quite widely. Multi-agent systems are composed of multiple interacting computing elements, known as agents. Agents are computer systems with important capabilities. Agents are sophisticated computer programs that acts autonomously on behalf of user. This system gives to support buyers for selecting the best product most closets of theirs desired and also support the sellers that theirs product are sold out till they meet their desired. The bargaining process also plays for them to get satisfaction theirs designation.

2. Related Work

In the recent past, many online stores allow customers to comment or rate their items. There are also dedicated review sites that host user reviews for different products in developed country.[2] Tokuro Mastsuo and Takayuki also presented a decision support system for group buying based on buyers' preferences in e-commerce. In that case, the problem is how to distribute social surplus. In such game theory, group buying is often discussed in relation to the coalition game. [3]In real world, the e-commerce system is developing. However, these approaches have some problem of how to bargain between sellers and buyers. Deng-Neng Chen, B.Jeng [4] presented buyer collective purchasing system on multi-agent system to increase the development of e-commerce. The nature of the tasks involved in e-commerce, it has been suggested that agent technology will play an important role in its development. In this paper, AHP with Multi-agent will support buyers and sellers to get satisfaction by using bargaining system.

3. Decision Support System (DSS) and Analytic Hierarchy Process (AHP)

Developing E-commerce system requires making decisions and selecting technologies to support those decisions. Some background theory is presented as following.

3.1 Decision Support System (DSS)

Decision Support System (DSS) is a computer based system. It assists management decision making by combining data, sophisticated analytical models and tools, and user-friendly software into a single power full system that can support semi-structured or unstructured decision making where no one know exactly how the decision should be made. There are three levels of DSS technology. They are Specific DSS, DSS generators and DSS Tools. A Specific DSS is the actual system that a manager works with during the decision and is constructed with the use of DSS generators or tools. DSS generator is a software package that provides capabilities for building specific DSSs rapidly and easily. A variety of tools

may be employed as building blocks to construct a DSS generator or a specific DSS including many programming languages and it is also widely used in the e-commerce.

3.2 AHP (Analytic Hierarchy Process)

The AHP is a structured technique for dealing with complex decision. Rather than prescribing a "correct" decision, the AHP helps the decision makers find the one that best suits their needs and their understanding of the problem. Users of the AHP first decompose their decision problem into a hierarchy of more easily comprehended sub-problems, each of which can be analyzed independently. The elements of the hierarchy can relate to any aspect of the decision problem. The AHP is a popular and powerful multi-criteria decision support method. It is designed to select an optimal choice from a number of alternatives according to a set of computing criteria. The AHP is devised to synthesize the common needs from the buyer group. Based on the created AHP tree, a one-to-many negotiation algorithm takes place to seek for the best from seller that carry products satisfying the group's needs.

A detail description of the AHP method is summarized below:

Step 1: Create a hierarchical representation of the decision problem by recursively breaking it into a set of criteria. A typical multi-criteria decision problem consists of three components: objective, criteria, and alternatives.

Step 2: Make pair-wise comparisons of the attributes and calculate the principal eigenvector (a mathematical approach used by AHP) of the matrix derived from the comparative judgments.

Step 3: Transform the comparison results into link weights in the AHP.

Step 4: Use the link weights to evaluate each alternative. This is done by multiplying the weights of criteria that link to the alternatives and summarize them up all the way through the links to the root of the tree. The result scores rank the alternatives so that one can make a provisional decision. [5]

4. Multi-Agent System (MAS)

Multi-agent system (MAS) is one that consists of a number of agents, which interact with one another, typically exchanging messages through some computer network infrastructure. [6]In theory, MAS are usually characterized in terms of internal behaviors and external interaction between agents.

The main properties for characterizing the internal behavior of agents are: the type of cognition and performance measure they utilize in choosing how to act. Many characterize the environment in which they are situated, including their computation infrastructure and their social environment with other agents; and the degree of autonomy of their actions in their environment with respect to other agents, a human owner, and their execution. The main properties for characterizing the external observable behavior inter-agent interaction are: how they interact to share tasks and share information, how they interact as part of different types of social organizations and their degree of cooperation with other agents. [7]

4.1 Responsibilities of each agent

Multi-agent systems are systems composed of multiple interacting computing elements, known as agents. In this paper, there are six agents. They are initiator, coordinator, negotiator, search agent, buyer agent and seller agent. The responsibility of each agent is as shown in figure 1 and the operation step is as shown in table 1.

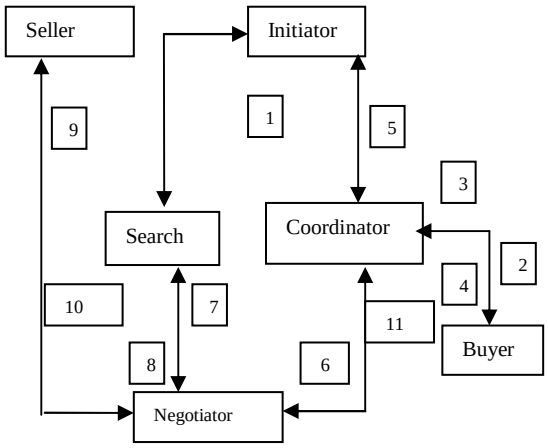

Figure 1. Responsibilities of each agent

Initiator agent: This agent's responsibility is to generate n initial plan and to identify potential sellers. The initial plan is built with the help of domain experts, who are able to describe the criteria of what must be taken into the purchasing plan.

Coordinator agent: This agent's responsibility is to broadcasts the plan to interested people over the internet, and collects the preferences of each individual participant. Coordinator synthesizes the individual buyers' preferences and converts them into the hierarchy tree.

Negotiation agent: This agent is responsible for negotiating with sellers, with respect to the preferences that have been collected from a group of participants and represented in the form of AHP

criteria. The goal is to bargain with candidate sellers for a best offer that satisfies the most demands and preferences of buyers.

Search agent: This agent is responsible for searching the sellers and theirs proposed products.

Buyer agent: When a person is interest in this system and wishes to join in it, s/he can register and give preferences for the option items.

Seller agent: When a person wants to sell their product, they can participate by uploading theirs products in option item and gives minimum price that is acceptable price and gives described price to the buyer. The step of each agent operation is as shown in following table 1.

Table 1. Explanation of responsibilities of each agent

	Operation	Explanation
1	Initialization	Initiator sends the initiatory plan to Coordinator
2	Broadcasting	Coordinators sends the initiatory plan to Users
3	Registration & preference-gathering	Users register to the purchasing group, and give/modify the weights of preference.
4	Buyer Agent	Buyer Agent is responsible for each registered user
5	Notification	Coordinator sends the group preference to Initiator
6	Calling for negotiation	Coordinator sends the buyer's preference to Negotiator
7	Seller Searching	Negotiator asks Search Agent to search suitable sellers
8	Seller Collecting	Search Agent returns a Seller's products to Negotiator
9	Inquiring	Negotiator asks quotations from sellers
10	Offer-gathering	Sellers send their offers to Negotiator
11	Reporting	Negotiator sends the result back to Coordinator

4.2 The Bargaining Step

The bargaining task is based on a negotiation. Price is an income for the seller, but a cost for buyer. Thus, the price issue was worth for each part. In this system, the buyer can negotiate with multi sellers until they get satisfaction. The following bargaining step is as shown in figure 2.

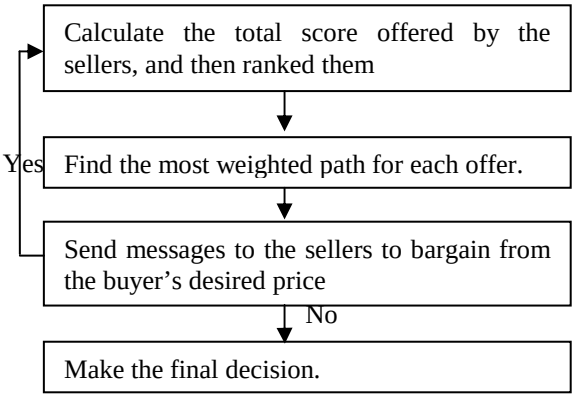

Figure 2. Bargaining Step

5. Implementation of the System

In this system, there are two parts: seller part and buyer part. In the seller part, each seller can get opportunity to adjust their product's information until getting satisfied and can also upload theirs products. Also buyer side, although not knowing about of personal computer, buyer can get most suitable product closet of theirs requirement by using AHP on multi-agent. Moreover, the buyer can negotiate about the price of their desired products directly with that product's seller. Multi-seller and multi-buyer can play to get their designation and the bargaining process gives the acceptable price that satisfied theirs desired.

5.1 Decision Support System using AHP

AHP is suitable for complex decision making. The system considers selecting the best brand for computer is decided by an agent's utility based on AHP. The calculation is as shown in following. [4]

Step 1: Setting up the hierarchy as shown in figure 3. There are multiple comparisons to make the decision by using AHP. In this paper, three alternative comparisons are presented as an example.

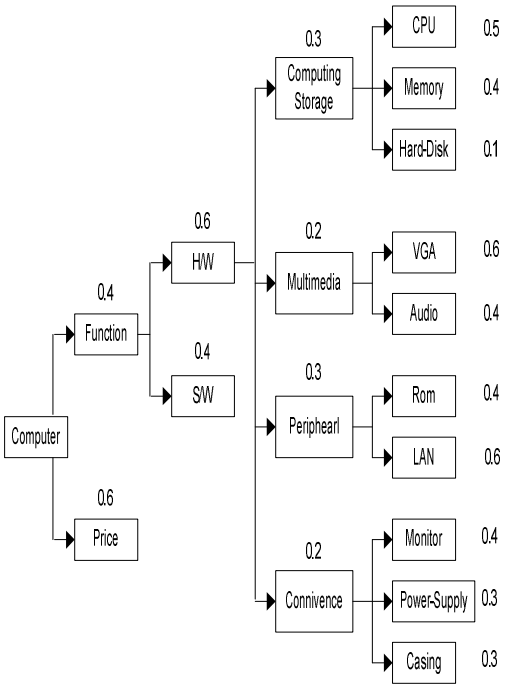

Figure 3. The hierarchy for selecting the computer by using comparison formula.

Step 2: Define the number of comparison by using n (n – 1)/2.

Step 3: Define the reciprocal matrix from rating the user's preferences as shown in figure 4. If the judgment value is on the left side of 1, put the actual judgment value. Otherwise, the judgment value is on the right side of 1, put the reciprocal value. The diagonal elements of the matrix are always 1.

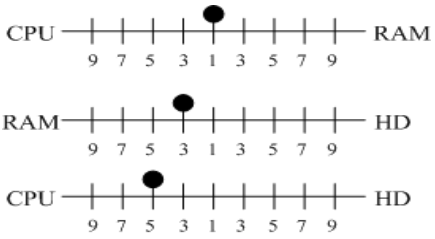

Figure 4. Rating the user's preferences

Table 2.Definitons of number

Number	Definitions
1	Equal
3	Slightly Favors
5	Strongly Favors
7	Very Strongly Favors
9	Extremely Favors

Step 4: Making the reciprocal Matrix as following.

$$\begin{array}{c} \\ \text{CPU} \\ \text{RAM} \\ \text{HD} \end{array} \begin{array}{c} \begin{array}{ccc} \text{CPU} & \text{RAM} & \text{HD} \end{array} \\ \begin{pmatrix} 1 & 1 & 5 \\ 1 & 1 & 3 \\ 1/5 & 1/3 & 1 \end{pmatrix} \end{array}$$

After calculating, the result is as shown in follow.

$$\begin{array}{c} \\ \text{CPU} \\ \text{RAM} \\ \text{HD} \\ \text{Sum of each col:} \end{array} \begin{array}{c} \begin{array}{ccc} \text{CPU} & \text{RAM} & \text{HD} \end{array} \\ \begin{pmatrix} 1 & 1 & 5 \\ 1 & 1 & 3 \\ 1/5 & 1/3 & 1 \end{pmatrix} \\ 2.2 \quad 2.33 \quad 9 \end{array}$$

Step 5: Normalization to get relative weight. It is need to be the sum of each column is 1.

$$\begin{array}{c} \\ \text{CPU} \\ \text{RAM} \\ \text{HD} \\ \text{Sum of each col:} \end{array} \begin{array}{c} \begin{array}{ccc} \text{CPU} & \text{RAM} & \text{HD} \end{array} \\ \begin{pmatrix} 0.45 & 0.43 & 0.55 \\ 0.45 & 0.43 & 0.33 \\ 0.1 & 0.14 & 0.11 \end{pmatrix} \\ 1 \quad 1 \quad 1 \end{array}$$

Step 6: Generating weight value.

$$\text{Weight} = 1/3 \begin{pmatrix} 0.45 + 0.43 + 0.55 \\ 0.45 + 0.43 + 0.33 \\ 0.1 + 0.14 + 0.11 \end{pmatrix}$$

$$= \begin{pmatrix} 0.4866 \\ 0.4033 \\ 0.1166 \end{pmatrix}$$

To find the weight value of all branch of tree this system need to calculate total score as shown in following.

Step 6: To make the total score, use the following formula.

$$\text{Max}_{j=1}^{m} = \left(\sum_{i=1}^{n} W_i \times S_{ij} \right)$$

w=path weight
s=product score
m=number of seller
n=number of sub-criteria

5.2 Design of the System

The main goal of this system is to increase the possibility of the agents to get all the products desired by the buyers and sellers. From the perspective of the sellers, the system enables to get satisfaction about theirs uploaded products in the option items. From the buyer side, the system enables to get desired price on the uploaded products in the option items. The bargaining system is effective for both buyers and sellers to get theirs destination. The following sequence diagram of the system is shown in figure 5.

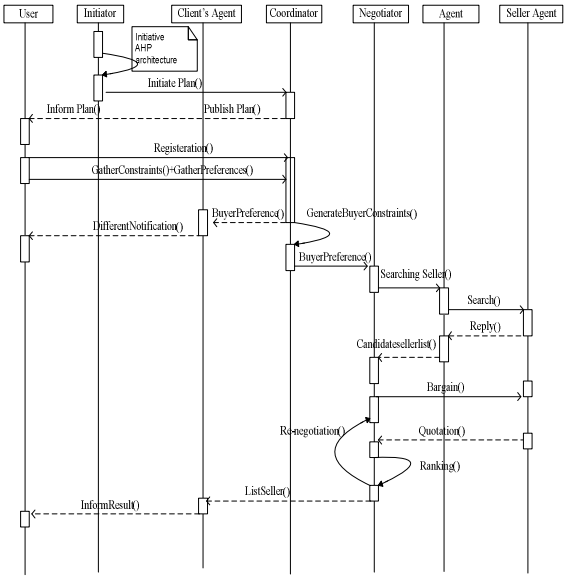

Figure 5. Sequence diagram of the system

In this paper, the functionality of buying and selling in e-commerce is made possible through internet. Comparing the buyer's preferences is more computationally intensive. There is more convenient for buyers if the selecting of alternatives hierarchy is more. Although the computing speed can be delayed, this system can be able to handle.

6. Conclusion

E-commerce also provides a way for the business to connect its buyers, sellers, suppliers and employees all over the world. The AHP is a simply and practical decision method, can be used to completely and scientifically evaluate alternatives. AHP helps managements make timely and effectively decisions by providing reliable and relevant information in the correct format and at the right time. By using Multi-agent system, the process can operate parallel and efficient of load balancing between buyers and sellers. Moreover, the bargaining system for buyer and seller gives satisfaction by providing price analyzing services to assist in the decision making process.

7. Reference

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