A proposed Decision Support System for Trips Selection

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Abstract

The Trips selection will become even more important nowadays especially as online trips in large trips databases can be used to give online travelers a better choice of trips than can be found off-line.

The process of selecting a trip is considered as one of the most difficult stages a traveler goes through, especially with tens of trips of similar goals, different prices and detailed characteristics in the market.

This paper is interested in proposing a Decision Support System to select the optimal Trip that meets each traveler's preferences; using Case- Based Reasoning techniques 'CBR', and calculating similarity between the traveler's preferences and the trip characteristics.

Key word : Decision Support System, trips, Case- Based Reasoning techniques

JEL Classification: l90,l91,l92

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1.Introduction

The trips selection will become one of the most important areas nowadays especially as online trips, large trips databases that can be used to give online travelers a better choice of trips than can be found off-line." [1].

The process of selection trips is one of the most important issues that concern the traveler, who wants to get as much characteristics as possible. Many travelers fall into the common error of selecting the trips depending only on its characteristics and prices, paying no attention to how the trip matches previous similar cases, or the importance of each characteristic in the selection process, which this paper goes through.

Let us assume that we want to select a trip for your holiday, and there are many trips, different in prices and characteristics. The main question is how are you going to select the trip that meets your preferences within the budget you allocate, without paying more money to characteristics you will not use?. One of the most traditional ways is to get a list of trips characteristics "RFI1" and prices and make a comparison among them order to find out the best trip which has the least cost and best characteristics, without taking into mind how suitable is this trip to your case. This way leads you in many times to pay more money for some characteristics that you don't need, for instance paying for the French language support without your need for it at all.

Decision support systems have become from management decision systems in the early seventies [2], then later they were defined by Keen and Scott-Morton as following: "Decision support systems couple the intellectual resources of individuals with the capabilities of the computers to improve the quality of decisions. It is computer-based support system for management decision makers who deal with semi-structured problems." [3]

The use of expert systems for trip selection and configuration is a well-established idea in the early eighteenth (e.g. the R1 system used for configuring Dec VAXs [4]). More recently, Case Base Reasoning has been applied at a number of different levels.

One of the most famous approaches is to focuses on the CBR cycle of retrieval, reuse, revision and retirement [5]. This work in the information retrieval domain, where iterative searching is becoming more important [6], and the convergence of case-based reasoning, information retrieval [7] and knowledge management processes [8]. Some Extensions of the CBR cycle have also been proposed to support trip selection and sales like [9]; Case-

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process whose purpose is businessA request for information (RFI) is a standard 1
to collect written information about the capabilities of various suppliers. Normally
it follows a format that can be used for comparative purposes.

based reasoning (CBR) technology emerged as a new important possibility [9], [10].

Using the Case based Reasoning "CBR" techniques in the decision making process is one of many methods raised with the appearance of data mining techniques [11]. This method is interested in looking for answers depending on the previous, finding the optimal trip is realistic and suitable to the traveler's preferences, which is in addition to the producer answer the same collection of questions that are related to the selection process.

1.1. Literature

Case-Based Reasoning is implemented in large scale in many arias. Authors in [12] presented a case-based reasoning decision support system (CBR-DSS) that assists contractors in solving markup estimation problem. Their CBR-DSS use successful cases of previous completed projects to derive solution to new project markup estimation problem, the principle of the CBR-DSS was to analogy new project with previous projects.

(Schmitt et al, 1999) suggested applying Case-Based Reasoning technology for Trip Selection and Customization in Electronic Commerce Environments [13].Another study is given in (Kun-Hsiang et al, 2010) which focused on strategy selection for trip service system design, in their study Case-based reasoning is utilized to provide suggestions for finding an appropriate strategy [14]. Another study is given in [Ricci and Worthier, 2002] paper is based on Case Based Reasoning (CBR), it adapts its dialogue as it learns more about the user, supports trip aggregation for a given travel, provides personalized recommendations based on previous system experience, and it applies query refinement methods helping to adjust queries according to the data available in a given trip catalogues [15].

(Zigong Yin, Yuanfu Li. 2010) propose an intelligence decision support system based on case-based reasoning developed for bridge monitoring which needs visual inspection data and non destructive testing. Their system is composed of database system, bridge rating expert system, optimum maintenance planning system, and bridge monitoring strategy support system, which are established according to the management flow of bridge monitoring and bridge evaluation strategy. [16]

(Vinit Kumar et al, 2007) suggested the framework of a Decision Support System adopting Case-Based Reasoning approach; which can support decision makers in preventive as well as interceptive construction supply chain risk management [17]. Other use of CBR is to present a negotiation agent that applies Case-Based Reasoning (CBR) techniques to capture and re-use previously successful negotiation experiences in the multi-agent negotiation context [18]. Case-Based Reasoning can be used in diagnosis and troubleshooting applications[19], in Housing Prices [20], trip fault

prediction modeling [21], in Solving Examination Timetabling Problems [22].

(Kadoda, G at el, 2000) suggest using Case-Based Reasoning to Predict Trip Project Effort, they mentioned that in the situation of effort prediction CBR might be deployed as follows. In their paper they assumed they have n projects or cases, each of which needs to be characterized in terms of a set of p characteristics. In addition, we must also know the characteristic that is to be predicted. Historical project data is collected and added to the case base. When a prediction is required for a new project this case is referred to as the target case. The target case is also characterized in terms of the p characteristics. Incidentally this imposes a constraint on the characteristic set in that it should only contain characteristics for which the values will be known at prediction time. The next step is to measure similarity between the target case and other cases in the p dimensional characteristic space. The most similar cases or projects are then used, possibly with adaptation to generate a prediction for the target case. Once the target case has completed it can be added to the case base [23].

1.2. Motivation

In this work, we focus on proposing a decision support system to help people in selecting the optimal trip using CBR technique. Optimal has first appears in 1890, it means "most favorable", So we are looking for best possible compromise solution to a problem, when there are several competing considerations, not all of which can be simultaneously maximized. The solution is induced by applying CBR steps through the process of retrieving the stored cases, calculating the similarity ratio between these cases and the new case, and then selecting the most similar case. Our novel idea is in suggesting a new similarity measure.

2. Case Based Reasoning

In this section, we will describe CBR as the fundamental technology for our approach. Case-based reasoning (CBR) is a method for problem solving that uses a database of previously encountered problem solving incidents as its core representation. The presumption in CBR is that past problem solving behavior is the best predictor of future problems and solutions [19]. A case-based reasoning solves new problems by using or adapting solutions that were used to solve old problems offers a reasoning paradigm that is similar to the way many people routinely solve problems. According to Hume (1748), "From causes which appear similar we expect similar effects." Hume went on to assert that "This is the sum of all our experimental conclusions." A recent formulation of decision making by Gilboa and Schmeidler (1995, 2001) provides a formalization of the ideas of Hume [24]. Gilboa and Schmeidler's Case-Based Decision Theory (CBDT)

suggests that similar actions in similar problems give similar payoffs. Indeed, actions are evaluated according to the similarity weighted sum of payoffs they have yielded in similar problems.

The basic idea of CBR is to solve new problems by comparing them to problems already solved. The key assumption is that if two problems are similar, then their solutions are probably also similar. In electronic commerce, a problem is typically the assignment of a particular trip to a set of demands (or preferences) stated by the customer. CBR systems are based on some measure of such similarity, i.e., trips are selected based on the similarity of preferences.
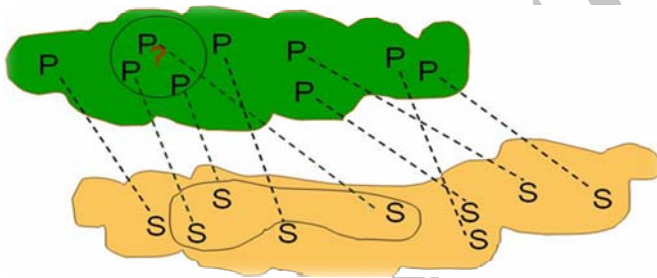

Figure1: Principle of CBR

The problem description is a specification of a single trip and possible demands the trip can satisfy. The solution for this problem is an unambiguous reference to the trip. When a customer enters a query (perhaps into a query form), the query is regarded as a new problem and the CBR system tries to solve it by comparing it to the cases in the case base

CBR is considered as one of the artificial intelligence techniques to build an expert system, where the knowledge base induced by experiments and previous experiences called Cases is used. Any new problem will be solved by founding the most similar case to the new case, then, will be re-used to be the solution for the new case. The new case will be stored in the knowledge base to solve other problems in the future. The following figure demonstrates the general mechanism of CBR algorithms:
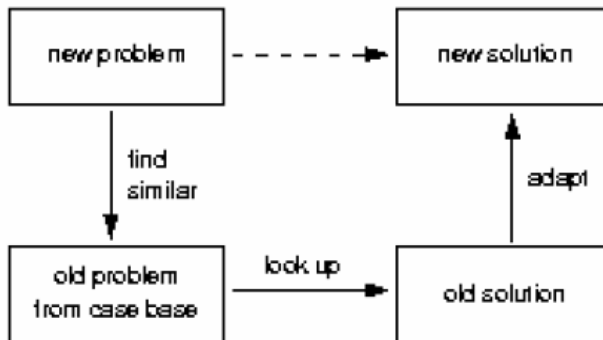
Figure 2. General processing within a CBR system.

2.1. CBR application stages

Trip retrieval: in this stage, the preferences are specified, and the closest trips to the new case which is the traveler's preferences are found. This stage involves many sub- stages:

Describing the needed characteristics and their degree.

Finding the similar trips to the new case.

Selecting the best similar trip.

Case reuse: The process of reusing knowledge takes into account considering the differences between the old case and the new case, and the fact that some parts of the old case can be transformed to the new case. There are two ways of the reusing process:

Copy the solution: where the solution of the old case is copied to be a solution of the new case.

Adapt the solution: where the solution of the old case is used in the new case, after making certain modifications.

Case Revision: At this stage, the solution for the new case is tested and revised in case of failure. This stage consists of 2 steps:

Solution evaluation: the solution is evaluated through applying it in reality, or by asking an expert.

Error correction: errors are discovered, and the solution is changed to get rid of errors.

New case retention: The new case is retained in the knowledge base to be used in the future, and, consequently, CBR represents the deduction process, the knowledge induction, and solution of problems through reusing previous cases, as the figure3 shows.
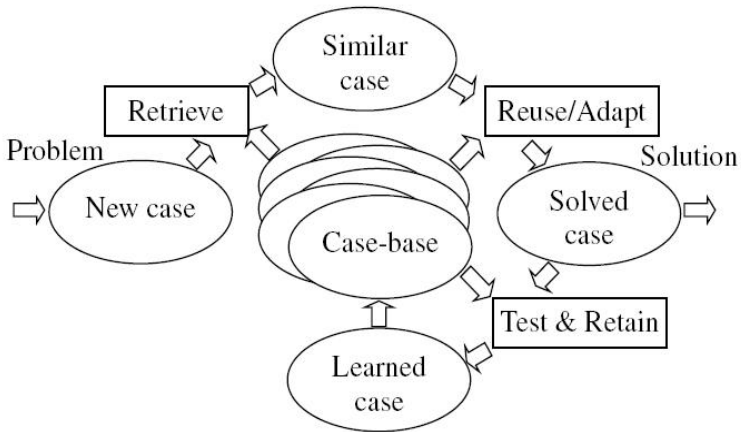
Figure 3: CBR stages

3. Similarity measure

The most important step in CBR System is case similarity measure. Whether the system can get similar trip sets to the target case by retrieving, how it calculates the similarity between the source case and the target trip, and how it selects the suitable trip that has the greatest similarity.

The similarity values are often normalized to the interval [0, 1]. A value of 0 means "does not satisfy my needs at all" and a value of 1 means "it is exactly what I asked for". To understand how such a similarity measure is used to find the best choice for trips selection, consider the trip being represented as a fixed length vector of n characteristics. On the other hand, the traveler has his own preferences on the degree he wishes for each characteristic, and the similarity measure will find the best trip for him.

There are three steps to find the matching or total similarity as following between the traveler's preferences and trips characteristics as following:

Calculate the similarity of relevant characteristics between the preferences on preferences and the trips characteristics.

Calculate the full similarity between the current preferences and the past similar trip, and get the similarity.

Sort all the candidate similar trips according to the similarity them and the traveler's preferences, and select the trip that has the greatest similarity as the solution of the current problem.

There are many matching methods can be used in the process of evaluating the full similarity, we will discuss them in the following section toward introducing our similarity measure in trip selection selections.

3.1. Similarity measure in CBR

3.1.1 Euclidean distance

Euclidean distance can be used between two cases. If the two cases are characterized by N continuous variables : X (x1, x2, … xi, … xn), Y (y1, y2, …yi, …yn) then the Euclidean distance is given as flowing:

$$d_{X,Y} = \sqrt{\sum_{i=1}^{p}(x_i - y_i)^2}$$

3.1.2 Nearest Neighbor Matching Function

Nearest-neighbor retrieval is a famous approach that computes the similarity between stored cases and new input case based on weight characteristics. A typical evaluation function is used to compute nearest-neighbor matching [11].

Where Wi is the importance weight of a characteristic, sim is the local

$$similarity(Case_I, Case_R) = \frac{\sum_{i=1}^{n} w_i \times sim(f_i^I, f_i^R)}{\sum_{i=1}^{n} w_i}$$

similarity function of characteristics, and f_i^I and f_i^R are the values for the characteristic i in the input and retrieved cases respectively. We have to find out a mechanism to determine the ratio of matching between a trip and the traveler's preferences via calculating the ratio of matching between set of characteristics in the trip and its counterpart that is required by the customer. There are three types of local similarity measures:

Exact similarity measures: similarity is 1 if the characteristic values are equal, otherwise it is 0.

Difference based similarity measures: Similarity is directly related to the difference, between characteristic values.

Complex Similarity Measures: Any similarity measure that is different to the above representations falls under this category. It is impossible to provide for a representation scheme that could cover every possible type of complex similarity measure [26].

3.2. Our Proposed similarity measure

We have started from the typical similarity function which is proposed by Kolondner in CBR systems[11].Local similarity sim is calculated rationally as following [27]:

$$sim(f_i^I, f_i^R) = 1 - \frac{\left|f_i^I - f_i^R\right|}{k_i} \qquad EQ\,1$$

where k_i is the scale value of the characteristic i. From our point of view, this function is not suitable for trips selections, because when a trip has a characteristic supported more than what needed, it will be considered as it is not supported. For instance when we have two trips P1 and P2 with the following support's degree of characteristic.

	A	B
P1	10	7
P2	10	3

Table 1 support's degree of characteristic

On the other hand, one customer has the following preferences as Table2.

	A	B
C	10	5

Table 2 customer's preferences

Applying EQ1 For characteristic B, we get that: Sim (P1, C) = 1- |7-5|/10 =80%, and Sim (P2, C) = 1- |3-5|/10 = 80%, whereas in fact P2 is better than P1 because is more supported. This leads us to enhance this function to be more realistic for trips selection.

we propose The following definition of the local similarity between two characteristics "the ratio of the Minimum level the traveler wants to his trip to contain to degree of support the trip has for this characteristic, but without exceeding 1".

Let us assume:

P: The degree of support a trip has for the characteristic.

C: The Minimum level the traveler wants to his trip to contain for the characteristic.

So the local Sim is:

$$
\begin{cases}
0 & \text{If } \{C = o\} \\
0 & \text{If } \{C > P\} \\
P/C & \text{If } \{P > C\}
\end{cases} \qquad EQ\ 2
$$

3.2.1 Example:

Assuming that we have three trips P1, P2, P3, with the following main characteristics A, B and C. The Minimum level the traveler wants to his trip to contain is as following.

The characteristic A is: Essential for you and has 10/10.

The characteristic B is: Desirable for you and has 5/10.

The characteristic C is: Not important to you and has 0/10.

There are the following trips P1, P2, P3 which have the degree of support of characteristics A, B, C.

	A	B	C
P1	7	7	0
P2	5	10	5
P3	10	1	0

Table 3 Example of three trips

The weight of each characteristic "wi" is calculated according to the importance of each characteristic to the total sum, for example:

WA = (A)/(A+B+C), The total sum of weights $\sum Wi$ will be always equal to 1.

Let apply our approach, first of all we have to move to the weighted preferences, Wa= 10/15= 0.66, Wb=5/15= 0.33.Applying our local sim EQ2 we have:

	WA	WB	We
C	0.66	0.33	0
Sim(C, P1)	0.7	1	0
Sim(C, P2)	0.5	1	1
Sim(C, P3)	1	0.2	0

Table 4 Applying EQ2

S(P1,C) = (0.7)(0.66)+ (1)(0.33) + (0)(0) = 0.792.
S(P2,C) = (0.5)(0.66)+ (1)(0.33) + (1)(0) = 0.66.
S(P3,C) = (1)(0.66)+ (0.2)(0.33) + (0)(0) = 0.726.

So in our approach P1 is the best option, Following the traditional approach, we will have that P3 is the best.

5. Methodology

5.1 Using CBR algorithm in the selection decision making:

The knowledge base represents the producers group that has certain trip with specific characteristics, where each trip is represented as a case, and the problem to be solved is that we have a traveler who wants to purchase certain trip with certain characteristics. This customer is represented as new good case, and what we need is to find the most similar case, the closest trip, that meets his preferences.

The solution is induced by applying the previous steps of CBR technique through retrieving the stored cases, calculating the ratio of matching between this case and the new case, and selecting the most similar case, but in our proposed system the new case is not stored as representing a traveler not a trip.

The new case is built gradually by asking the traveler a number of questions that represent the trip required characteristics, then, the stored cases are

evaluated, the similarity ratio between this case and the new case in each question is calculated, and eventually, the closer case is selected. This system also gives the customer the opportunity to acknowledge the differences between his demand and the closer trip characteristics.

5.2 Our Model:

There are two steps awards our model. First we should build the knowledge base that involves all the trips where data mining will be achieved to search for the best solution. The research propose calculating the matching ratio using CBR technique. To build this knowledge base, We have to determine the questions that are required to be answered, then, each producer's answers is stored, after that, a decision making process will begin by asking the traveler to answer the same questions beside setting the importance of each question, where the trips will be evaluated depending on the importance of each question for the user and its availability in the trip. This process will continue step after step until the final stage, where the user will identify the detailed functional preferences. The research is interested in finding a way to calculate the matching ratio between traveler's preferences and the trip's characteristics .

The system also aims to help the traveler to find really a trip meets his preferences, therefore, the traveler at a certain question can select only the answers which is existing in the knowledge base. This knowledge base represents only the available characteristics of trips and the system also eliminate the question in case all the trips in the knowledge base at a certain question have the same characteristics, then, these qualities are considered the new case characteristics, and the question will not be asked. The rules will be induced

Depending on one of the data mining tools, which are inducing Association rules to find the relationship between the questions and the answers? FP-Tree algorithm will be applied, and Association rules will be induced besides identifying the ratio of min confidence as equal to 100%.

5.3 Building the knowledge base

The knowledge base is built through answering a number of questions. These questions include 2 sections: the first section is general, it involves questions about the traveler's work environment. The second section is detailed. It involves the detailed preferences of the required trip. The general questions involve scenarios of any traveler's need for trip.

Let us assume a traveler needs to select a trip, the question file includes the following points, in addition to the fact that it is possible to add or delete a question depending on the nature of the trip required to be evaluated.

When adding a trip, a number of options are set to be as suggestions for the traveler. A new option can be added in case of unavailability. This

characteristic makes the knowledge base dynamically updated, so that the knowledge base is not limited to the options we specify. The options should include "not important" option which should be valid for the traveler, this option reflects the fact that the traveler dose not care about this question.

These questions is an example of Trips selection.

Categories: Please indicate category of your interest.

Cost: Which is the budget of the trip?

Date: which is the date you prefer.

Transportation: Please select the kind of transposition you prefer.

Accommodation: Please select the type of accommodation you prefer.

Language Supporting: what languages are available .

Duration: How is long of your trip .

Please indicate your specific requirements.

5.4 Weighting factor:

As the traveler answers each question, he assigns the question importance parameter, in which he expresses how important each question for him is. The more important the question for the traveler is, the higher the evaluation of the trip which includes this characteristic is. Consequently, the trip are evaluated according to their support for this characteristic, and how important is it for the customer, and therefore, the degree of evaluation will vary from question to another, leading to the final question which requires to identify the detailed functional preferences. In case the percentage of the importance was 100%, this means that the customer wants the trip which exclusively includes this characteristic precisely. On the other way if the percentage was less than this, then, this means that there is no objection concerning the presence of another that support this characteristic partially, and the trips are evaluated according to their support for this characteristic, and consequently the degree of evaluation will vary from one question to another, until the final question when the traveler will determine the detailed functional preferences.

Identifying the percentage of matching of the detailed characteristics of the detailed functions:

The traveler answers the question that will be answer in another way "what is the minimum level you want to his trip to contain".

The characteristic A is: Essential for you and has 10/10.

The characteristic B is: Desirable for you and has 5/10.

The characteristic C is: Not important to you and has 0/10.

5.5 Interfaces

Full source code is available, it is built using LAMP and customized in two study cases, Fist for selecting Customer Relationship Management programs, and the other for trips selection.

Here is some interfaces of the decision system:
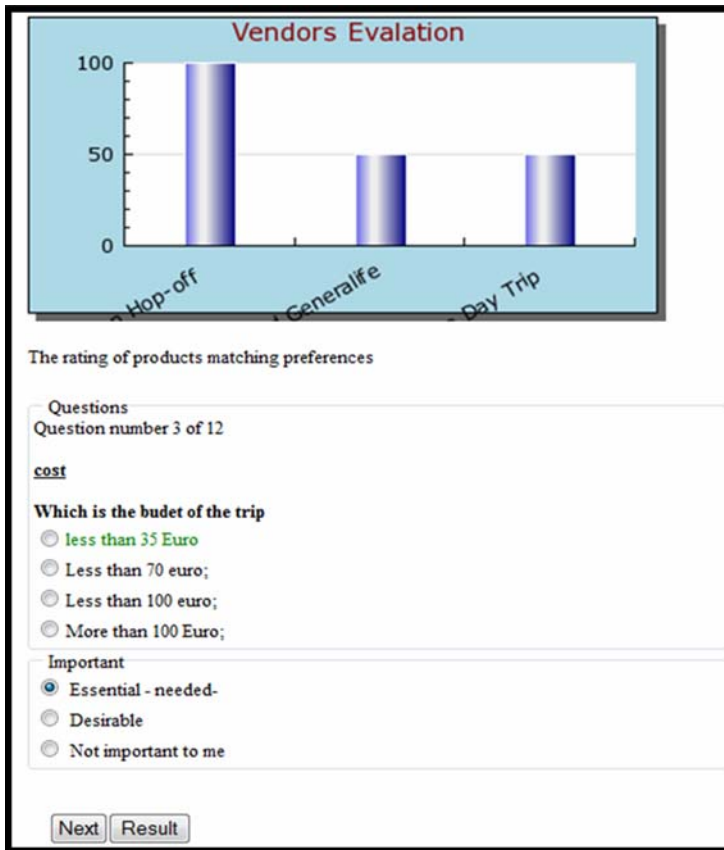

Figure4 Question screen
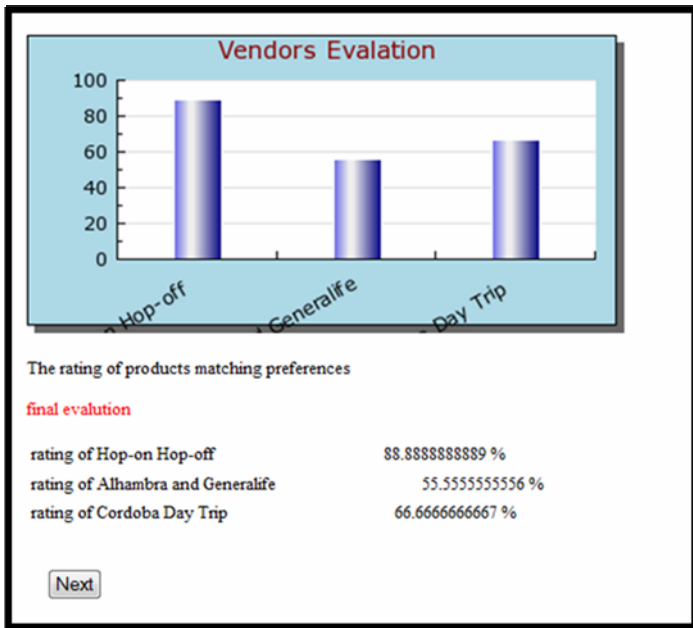
Figure5: Question screen with rating

Figure5: Final Results

6. Summary, conclusions and extensions

In this paper we have presented a proposal decision support system for evaluating trips using Case Based Reasoning, to help users to select the optimal trip that meets their preferences.

Finding a concrete manifestation of the term "similarity" is usually the task of a knowledge engineer, From our knowledge, there are no experiments to investigate similarity measure for trips selections, However, the last decade has seen a number of approaches that aim at using Machine Learning techniques to adjust the similarity assessment in Case-Based Reasoning.

We propose a novel similarity measure to calculate the ratio of matching between the client's preferences and the trip characteristics.

There are few experiments on similarity in general like Imai (1977), in the future, an experiment on similarity judgment will conducted in order to investigate how man processes information when a pair of configurations are presented, and therefore, investigate experimentally how people select trips, and finding out a similarity measure.

7. Acknowledgements

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