Intelligent Support for Internet Marketing with Case Based Reasoning

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Abstract

Internet marketing can suffer from a lack of personalised service and advice available in face to face contact. This paper discusses the potential use of Artificial Intelligence in the form of Case Based Reasoning coupled with multicriteria decision making using the Analytic Hierarchy Process to address some of these problems. A research project implementing these concepts is described.

Introduction

Marketing on or off the Internet is more than merely selling the product. It certainly needs to be more than simply displaying the product in the hope that customers will arrive and buy. Vassos (1996) states that " a comprehensive Internet marketing plan should focus on three objectives:

- Increasing sales
- Decreasing the cost of doing business
- Improving communications with all stakeholders."

He further argues that, although sometimes successful in the latter two, the Internet has often not proved to be very successful at increasing sales. Although the global reach of the Internet attracts organisations for its potential of reaching a vast market with specific goods or services, the lack of personalised advice and support in reaching a decision will deter customers from selecting many items, particularly if they carry a higher price. The automated interaction with a web site can make it difficult for a company to assist the customer in making a choice.

Many purchasing decisions are made by balancing and trading off a number of criteria, some of which may complement each other while others will act in opposition. A standard example would be some form of price/quality compromise. Such product selection is often a matter of iteratively refining the significance attached to specific criteria and seeing whether specific examples of the good or service required will fit the criteria or can be adapted to fit the criteria.

This paper will discuss the potential of an artificial intelligence technique, case-based reasoning, to provide intelligent support for the marketing function. The next section will provide a brief overview of some of the issues involved in marketing on the Internet. A section explaining case based reasoning will follow this. The use of CBR for marketing support will be demonstrated with a simple example. The use of multicriteria decision making as a tool to assist users to trade

off alternatives will be discussed. A prototype system developed by the authors to experiment with these concepts will be briefly described and discussed.

Internet Marketing

The explosive growth of the Internet has been seen as a potential goldmine by companies who perceive low cost access to international customers as a major return on a small investment. Seminars, short courses and new university degrees are being developed to cater for the expected growth. However successful use of the web for marketing has not proved to be easy. Companies such as David Jones have closed web sites that were considered advanced and full of innovation. Net News (16 June 1998) reports that "banner Web ads, which account for two-thirds of the $1 billion in online advertising, just aren't working the way they used to. The average click-through rate, according to Netratings, is about 1% whereas two years ago it was 2%".

A key component of successful electronic commerce web sites appears to be the need to add value to the visit by the customer i.e. some reason to get them there, keep them there and get them to return as well as recommend the site to other customers. Vassos (1996) refers to this as the *Gift Economy* - "the need to offer some information of value, free of charge to all visitors, with no strings attached". People receiving something of value are more likely to return or recommend the site, which increases both the reach and the frequency of product exposure. Possible gift offerings could include free consulting, research reports, visa or other travel assistance, comparative vehicle analyses or stock market reports.
Electronic commerce has restructured the value chain in a number of industries, opening the possibility of disintermediation i.e. the elimination of intermediate players in the value chain. Service industries such as travel agencies are most at threat, with customers being given direct access to the information and bookings needed to deal with holiday and business travel. However, although access to the necessary information has been simplified, significant support for the decision of purchasing a specific good or service is not usually provided. The customer may still have a bewildering range of alternatives and the selection of the best option has traditionally relied on some form of trusted information broker or agent eg. the travel agent or investment adviser. This paper proposes that at least some of this decision support can be automated with multicriteria decision-making tools. Once a customer's preferences are established, a suitable set of likely solutions to the problem can be selected and adapted as needed.

Case Based Reasoning

Case based reasoning (CBR) solves new problems by adapting previously successful solutions to similar problems. The appeal of CBR as a problem solving approach lies in its familiarity - in many problem solving situations a solution will be based on a similar problem solved by us in the past. As an example, doctors would not usually start all diagnoses from first principles. They would in most cases recall similar cases of patients with the same symptoms and also recall what treatments have worked in the past. Treatments may be modified for the specific circumstances of this patient eg difference in ages, sex, weight, medical history, etc. might all suggest some need for adaptation of a past solution.

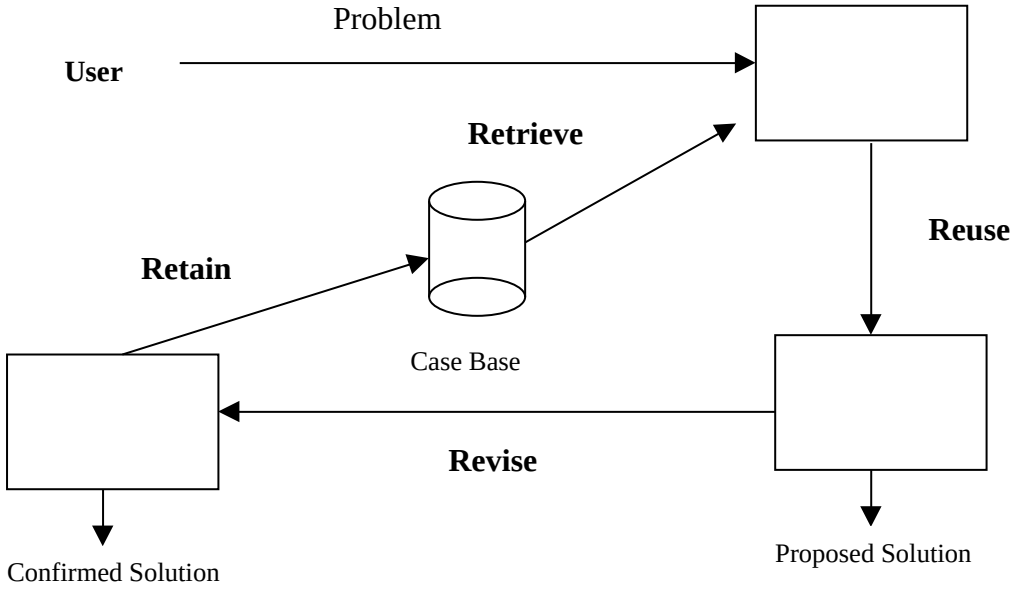


Figure 1: the CBR Cycle

The CBR process can be modelled by the cycle above (Figure 1) based on Aamodt and Plaza(1994). They describe CBR as a cyclical process comprising the four RE's:

1. RETRIEVE the most similar case(s)
2. REUSE the case to try to solve the problem
3. REVISE proposed solution if necessary
4. RETAIN the new solution

A new problem (the target case) is matched against cases in the case-base. The importance attached by the user to various features (indexes) of the case may be used to guide the matching process. One or more similar cases are retrieved from the case base. A solution suggested by these cases is reused and tested for success. If necessary, the retrieved case(s) will probably be revised to produce a new case which can then be retained in the case base.

The cycle normally requires some user intervention with most case adaptation in current CBR systems being largely performed by the user i.e. the CBR system acts as intelligent associative retrieval system. Key issues which need to be resolved in any CBR system are the following (Watson, 1997) :

(1) Case representation: how to structure cases and what case features should be stored
(2) Indexing: how to assign indices to assist case retrieval
(3) Retrieval: what retrieval algorithms should be used and what is meant by similarity? Techniques for dealing with similarity include nearest neighbour, induction and template retrieval.

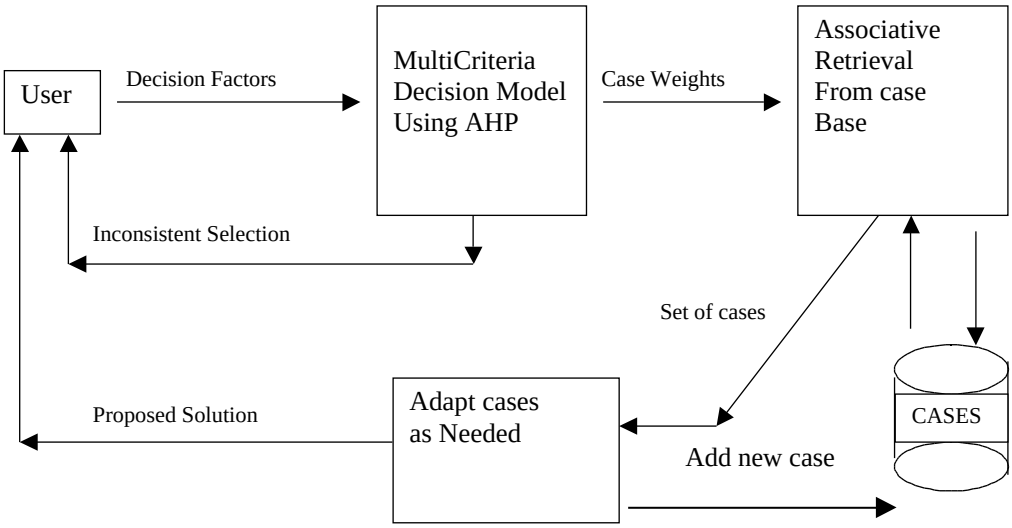
(4) Adaptation: How can the cases be adapted to solve the current problem?

Case Based Reasoning has established itself as a legitimate field of artificial intelligence, with two international conferences (ICCBR-95 and ICCBR-97) and a significant number of publications on the topic. CBR has been applied to a wide range of problems eg ship design (Lee at al, 1997), software development effort estimation (Finnie et al,1997) and Neuropathy diagnosis (Malek and Rialle, 1994).

Using CBR to Support Internet Marketing

The actual and potential use of artificial intelligence techniques to support electronic commerce has been explored in a number of areas, including the use of electronic agents and topics such as data mining and knowledge based systems (eg O'Leary and Gamble, 1997). The potential value of CBR in electronic commerce is only beginning to receive research focus. Wilke et al (1998])discuss the use of CBR to support negotiation with a customer. They argue that there is a need for intelligent advice during the selling of products via the Internet, and that CBR can provide such support in the form of adaptation of retrieved

Figure 2: A CBR Model for Internet Marketing



products to best fit the user's requirements. These authors use the example of used cars as a product that could be suitable for a CBR based sales agent. Wilke and his coworkers are part of the WEBSELL project centred at the University of Kaiserslautern in Germany. This project aims to develop "new Intelligent Sales Support technology and products for the World Wide Web"(Websell, 1998).

The research discussed in this paper is investigating not only the use of adaptation as a negotiation tool but also the incorporation of a decision support phase to assist in selecting a suitable set of similar cases for customer consideration and adaptation. The adapted model is given in Figure 2 above

This model allows on-line users to select products from a given case base according to their individual preferences. The model is suitable for moderately higher cost and/or long duration commodities in which customers must personally trade off a number of factors, some of which may complement while others will compete with each other. Vassos (Chapter 2, 1996) suggests a number of guidelines for the selection of products suitable for Internet marketing. The guidelines include factors like "the products should be targeted at above average levels of income and above average levels of education", "does the offering need to be physically seen?", etc. He notes that very expensive items may have difficulty achieving Internet sales success as buyers "are more likely to want to personally talk to the sales representative or personally test drive the product." The CBR model could provide some support in this type of market.

In this model the user will specify a problem as a set of factors (attributes) which define the problem. An example could be the selection of specific holiday alternatives eg. for a fishing enthusiast. The factors would again be diverse eg. type of fishing, locations, alternative attractions, costs, etc. The case solutions could be a specific package or combination of package components, which could be selected and matched during the adaptation phase. This would be a fairly active form of case base requiring constant maintenance.

As noted above, case retrieval requires some form of similarity assessment to determine the stored cases which are *most similar* to the current problem. Nearest neighbour search assesses the similarity between stored cases and the target case by matching a weighted sum of features. Nearest neighbour search has a retrieval time which increases linearly with the number of cases and is most effective when the number of cases is fairly small. The Remind system used for this research has a fairly typical matching algorithm given by the formula below, where ***w*** is the weight of a feature, ***similarity*** is the similarity function and (f^T_i, f^R_i) are the values for feature *i* in the target and retrieved cases.

$$\sum_{i=1}^{n} w_i * similarity(f^T_i, f^R_i) \Big/ \sum_{i=1}^{n} w_i$$

Determining a suitable set of weights is crucial to the success of this method. In its simplest form, users could simply be presented with a list of key factors and asked to assign a numerical weight which reflects the significance they place on this attribute relative to other attributes. These weights could then be used directly in the formula above to retrieve the nearest neighbours.

However in a variety of problem domains, particularly if there are a significant number of attributes, users may have difficulty in directly assigning weights. As an alternative, for this

research the analytic hierarchy process (AHP) is suggested as a means of establishing user priorities at a realistic level.

The analytic hierarchy process requires that a suitable hierarchy be set up to represent the attributes of each case (for example, figure 3 below). Once established, users need to perform a pairwise comparison of each factor with each of its sibling factors i.e. factors at the same level in

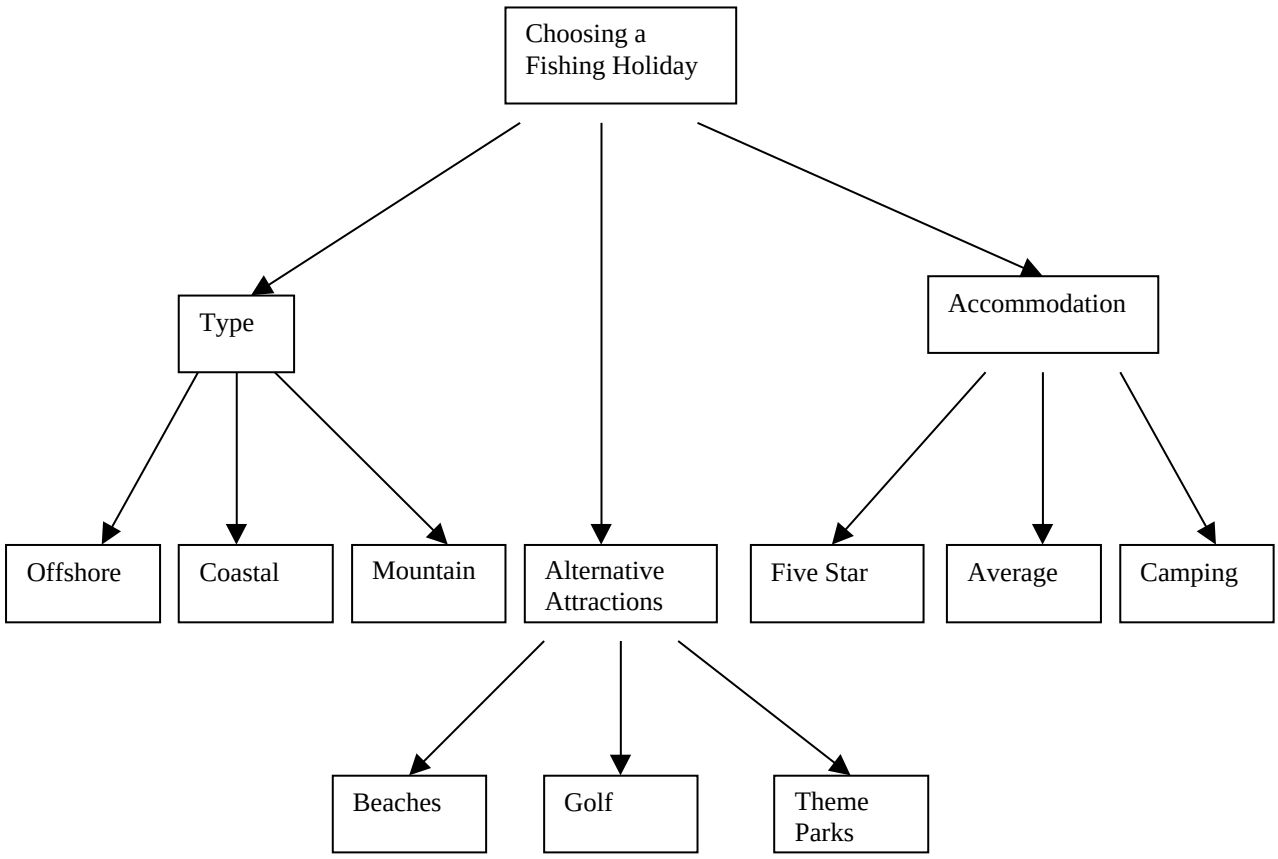


Figure3 : AHP Model for Fishing Holidays

the hierarchy. This comparison takes the form of asking the user to specify which factor they consider more important in the decision and by how much. Output from the AHP model is a set of weights reflecting the importance attached to each factor by the users. More detail on AHP can be found in such texts as (Saaty 1990, 1994). In most cases the AHP process is used to directly compare the alternatives in the decision eg a number of alternative models of car. The current approach stops one level before this comparison and simply uses the process to establish the relative importance attached to each factor involved in the decision.

The simple model in Figure 3 assumes three major criteria are considered in selecting a fishing holiday. These are type of fishing available, alternative attractions available and accommodation type (obviously in a real situation more factors could be incorporated). Each of these may in turn

be considered to have a number of alternatives that form the next level of the hierarchy. Output from the AHP pair-wise comparison process will be a set of weights reflecting the relative importance of such factors as offshore fishing, coastal fishing, golf, etc.

Once a set of cases has been retrieved, adaptation can be performed interactively with the user. For example, a holiday maker wanting to incorporate both fishing and golf may consider linking subsets of two stored packages. Adaptation looks for significant differences between the retrieved case and the target case and then applies formulae or rules that attempt to reduce the differences. Watson(1997) identifies two forms of adaptation used in CBR

(1) Structural adaptation, in which adaptation rules are applied directly to the solution stored in a retrieved case eg by substituting a component of the retrieved solution with an alternative value.
(2) Derivational adaptation that reuses the algorithms, methods or rules that generated the original solution to produce a new solution to the current problem.

The current research is investigating the use of structural adaptation. For either form of adaptation, there is a need to embed significant domain specific knowledge ie a system that advises on fishing holidays has to have significant knowledge (in the form of rules or other knowledge representation formalisms) that will allow it to adapt holiday alternatives to suit the customer. An example could be the need to know that extensive offshore fishing trips would not usually include golf as an alternative.

Discussion

A simple system has been developed to test the use of the AHP technique for case retrieval. The system uses Visual Basic ActiveX technology to create suitable web pages with ActiveX controls. Once a consistent set of user weights has been extracted, a set of nearest neighbour cases (using these weights) is extracted from a case base implemented in Remind. At this stage of the research the adaptation process has not been implemented. However the use of AHP does allow retrieval of what appear to be the best alternatives for a specific customer's needs from a small test case base.

The problem domain considered for the test system was the selection of a university for tertiary study. A number of factors such as cost, lifestyle, faculty status, etc were to be compared. About thirty Australian universities were rated on these characteristics and entered in the case base. A user is led through a series of comparisons of each pair of factors in turn. An example screen capture is given in Figure 4 where lifestyle and university status are compared. The comparison scale is an ActiveX component which pops up (with the label reflecting the specific factors) after the option button ("which is more important") is selected. At the end of each set of comparisons the consistency is checked and users can re-renter data if necessary.

The marketing of a number of products on the Internet requires the provision of intelligent support for the sales process. This intelligence and assistance can be provided at a number of stages. The model given here looks at three new aspects of intelligent support. Firstly, the use of

the analytic hierarchy process supports the user in trading off a number of competing factors using a multicriteria decision-making tool. The use of case-based reasoning allows the retrieval of a number of products which could be suitable for the customer, even if they do not match the original specification exactly. Lastly, the use of adaptation allows intelligent support for the customer in modifying possible products to determine their suitability.

Given the fact that both the AHP model and the adaptation process are very specific to the problem domain, it is likely this model will be more valuable for higher priced long-term goods or services rather than short-term consumables such as foodstuffs or entertainment. However, with the popularity of the Web for such ecommerce areas as travel, it is possible that the intelligent approach as outlined here has considerable potential for electronic commerce applications.

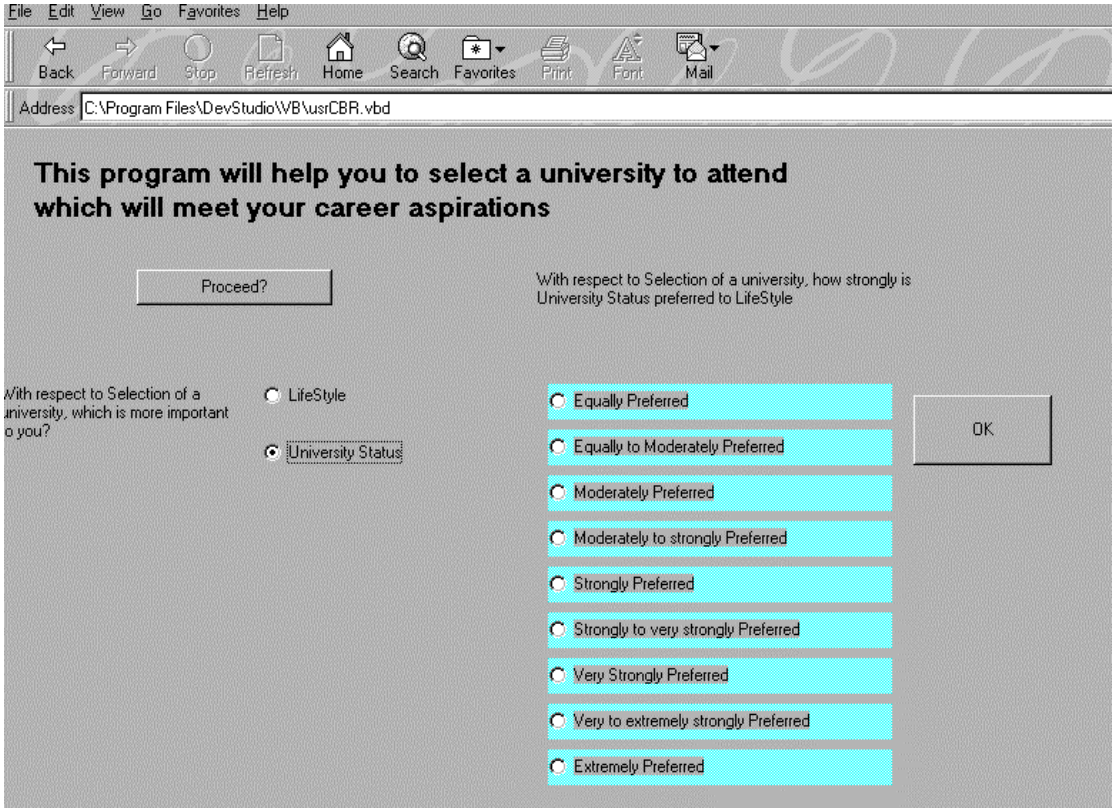


Figure 4: Example System Screen Capture

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