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Lozano Carmen (Professor, Department of Financial Economy and Accounting, Universidad Politécnica de Cartagena, Spain)

Fuentes Federico (Professor, Department of Economy. Universidad Politécnica de Cartagena, Spain)

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Procedure for Creating a Virtual Multibank Agent

Author (s)

Lozano Carmen
Department of Financial Economy and Accounting, Universidad Politécnica de Cartagena (Spain)
E-Mail: carmen.lozano@upct.es

Fuentes Federico
Professor, Department of Economy. Universidad Politécnica de Cartagena (Spain).
E-Mail: federico.fuentes@upct.es

Abstract

In this paper, we propose a procedure that makes it possible to create a virtual multibank agent that will assist potential banking customers in their decision making, who are demanding with respect to the level and quality of the banking services that they would like to receive, particularly when it comes to deciding to invest their savings or apply for financing for their expenses. The virtual multibank agent would act on two levels: first, it would optimize navigation through an online banking website; and secondly, it would sort through the banking information available online and refine this information in order to offer the best option among those available. Tabu search algorithms and the use of intelligent agents based on fuzzy logic by means of prior categorization are techniques that have proven to be useful in applications for the optimum distribution of information in the shortest amount of time possible, and the search for the best solution among all those available

Introduction

Over the past twenty years, banking has undergone a profound and rapid transformation, due to the liberalization and deregulation of the financial markets and the technological innovation applied to the fields of computer science and information technologies. Investors have benefited from an increase in the number of possibilities available for investing their money, whereas active clients can have access to cheaper financing, in a process of banking disintermediation.

The loss of banking business due to the competition of online business and the reduction of margins through financial intermediation has had to be compensated, generating revenue by providing services and reducing costs.

The new Internet technology has enabled and considerably simplified the tasks of capturing, storing and processing information, although the offer of online banking services has been growing exponentially over the past few years, at times causing banking consumers to feel "*flooded*" by such an amount of information, and at the same time in need of advice that, until now, consumers were obtaining by physically going to the bank. On the other hand, online distribution increases the range of products and services that banking institutions are able to offer their customers, offering interesting conditions on products in which consumers are more sensitive to the price: checking accounts, mortgage loans, etc., given that the presence of this channel enables banking institutions to apply differentiated pricing policies and practice cross-selling new products. For all of these reasons, it becomes essential to offer banking consumers a method for accessing financial information about products and services in a quick, efficient and direct way.

The metaheuristic tabu algorithm of resolution by neighborhoods is especially suitable for achieving the objective of optimizing navigation through an online banking website. With this algorithm, a "*memory*" is created which stores the last movements carried out in the navigation, which can be used to "*remember*" those movements that end up leading to solutions that have already been explored. This "*memory*" will serve to prevent the evolution towards those solutions. The properties of this algorithm make it ideal for optimizing navigation on websites by reducing wait times, "noise" (irrelevant information) in the search for information, and as a result, would reduce the number of users who leave the website and at the same time improve the quality of the navigation. On the other hand, the use of intelligent agents that sweep the Internet according to the user's information needs will enable users to not only obtain the information in the least amount of time possible, but they will also obtain a visual map of the actual pages, arranged according to their similarity with each other. Once one of the pages has been selected, the user can use this map to obtain those pages that are closer or more related to the particular query.

The application of both procedures, the tabu algorithm and the intelligent agent, will enable us to design a system that enables banking consumers to find, within the shortest amount of navigation time possible, information online about the desired product or service offered by all of the financial institutions that operate, according to some pre-established variables, which could be the capital (to be invested in savings products or to apply for in a loan), the interest rate, term or commissions, in this manner offering users the product or service that best adapts to their requirements. In short, the virtual multibank agent will enable users to look up information and will assist users in the decision-making process.

For the financial institutions that will be subject to the "*sweeping*" of information and its subsequent classification, the presence of the intelligent agent will also benefit them in the sense that the number of users who leave the site will be decreased, and hence the migration of their pages, at the same time that these institutions may reach more users given that the agent would be performing much broader searches on the Internet than those that a user would be able to perform individually, except in the case where the user were to invest a considerable amount of time navigating the Internet.

We are aware that the search systems that we establish will not be very exhaustive, even when handing very large databases, given that the Internet grows everyday; although without pursuing high percentages of thoroughness, what we aim to do is ensure that the results are precise and represent the solutions closest to the objective established by the user.

Using the Tabu Search Algorithm for Obtaining Online Information about Banking Products and Services

The problem that we are faced with is how a user is going to obtain information about a banking product at various online financial institutions. Each request for information will have an assigned access frequency, and based on that frequency, some possible combinations of dates on which to obtain the information [De los Cobos, S.G. (1994) pp.517-527].

This has to do with optimizing the navigation time in the period of time considered at the same time as minimizing the number of routes to follow in order to arrive at the desired information. The tabu search is a heuristic adaptive memory procedure that was first presented in research performed by Glover [1989, 1990], and has been gaining wide acceptance in recent decades when it comes to resolving complex problems (continuous and discrete, convex and non-convex, linear and non-linear problems, etc.) in different scientific areas. The tabu algorithm is used for exploring the space of solutions through repeated movements from a solution to the best of its neighbors, trying to avoid the local optimums, which thus enables movements that worsen the solution once arriving at a local optimum

[Costa, D. (1994)]. The main attributes of each solution visited are stored in a list and are classified as tabu during subsequent iterations in order to prevent the algorithm from cycling—that is, preventing the solutions from being revisited. Once a movement that generates a new solution is accepted, its inverse movement is added to the tabu list and it remains on this list for a certain number of iterations. Generally, the search ends after a certain number of iterations, or a predetermined amount of navigation time, or when reaching a given number of iterations that do not improve the solution found as the most adequate.

The solutions are determined by the times assigned to the navigation and by the routes designed for each access. In the problem of a user navigating through an online banking website, penalty costs due to delays and updating costs have been considered, both of a linear type.

We begin our study with the consideration of a maximum time dedicated by the user for navigating through the site in search of financial information. This time is broken down into 5 possible fields: 1 (obtain information about products), 2 (use simulators), 3 (entry of data), 4 (solve problems), 5 (buy product). At time zero, *N* accesses arrive at the page. Each access *i (i = 1, 2,...,N)* requires t_i units of navigation time and has a delay penalty for each unit of time p_i as of time zero; S_{ij} is the cost of updating the page j immediately after access *i*. Two false accesses *0* and *N+1* are included in each update, where $t_0 = t_{N+1} = 0$ y $p_0 = p_{N+1} = 0$. The costs $s_{0,i}$ y $s_{i,N+1}$ are considered as the costs of initial access and refining the information respectively. The navigation route through the page looks like the following: $\sigma = (0, \sigma(1), \sigma(2), \sigma(3), ..., \sigma(N), N+1)$, where σ *(i)* is the coefficient of access in the position *i of the page*. The objective is to minimize the total of the costs of updating D(σ) and delay for all of the accesses S(σ).

The tabu restrictions are not inviolable under any circumstance. When a tabu movement provides a better solution than any other previously found, its classification as tabu can be eliminated. The condition that enables such elimination is called *aspiration criteria.* Finally, we will establish finalization criteria based on which a maximum number of iterations can be established, or a maximum number of steps without improving the previous solution obtained. The iterations are presented in tables, where the number of iteration of the process is indicated, the itineraries generated and the corresponding values of the objective function, as well as the itinerary proposed for the tabu movement and the better movement acceptable in order to continue the process.

The complete neighborhoods[1] are examined, and the best change is made when obtaining the minimum value in the objective function and it is not a tabu movement or, in the case where it is a tabu movement, it must satisfy the aspiration criteria in order to be acceptable. For this case, the aspiration criteria are fulfilled if the value of the objective function improves on all the values previously found.

The matrix of frequencies enables recording the "*history*" of the procedure and that is what is used for forming the long-term memory function, thus enabling the diversification of the search as well as the possibility of directing the search towards "*nearest*" or "*furthest*" of the regions explored.

Let us suppose that in a navigation session at least two admissible movements are recorded which provide us the best values of the objective function, and therefore any one of the two may be chosen; in this case, the first is chosen, and the itinerary chosen would act as a starting point for the following iteration. In the case where itineraries with tabu movements are obtained in an iteration, but these satisfy the aspiration criteria, the itinerary with the

[1] Given a solution S, the neighborhood N(S) is the set of all the admissible solutions that can be generated by the execution of a movement on the current solution S.

smallest value in the neighborhood would be taken as the starting point for the next iteration.

In general, if there are not any admissible points in a given iteration and the stopping criteria has not been satisfied, the mid-term (intensification) and long-term (diversification) memory functions would have to be used in order to continue with the search.

Normally, the search is restarted based on the best current solution. Some options would be that of maintaining set components or attributes that appear to be better or to change the neighborhood scheme.

When navigating on the Internet, one of the main goals is to make sure that the search for information is as efficient as possible, and that implies reducing the search time, the elimination of unproductive routines in the search, or information that is not useful or sufficient for the navigator. The adaptive memory of the tabu algorithm exploits the history of the process of resolving the problem by making reference to four main dimensions consisting of the property of being recent, frequency, quality and influence. All of these properties make it a method that is especially useful in the most efficient search for information.

Then, in the second phase of our study, we will search for a procedure that enables "*discriminating*" the information obtained and selecting that which best adapts to a pre-established objective. When there are many variables, before designing any method of classification, it is necessary to select among the original variables those that are really relevant; that is, the problem has to do with finding a subset of variables with which it is possible to carry out the task of optimum classification. Thus, for instance, when searching for information about loans, the user would want to find the most amount of information in the shortest amount of time possible and with the minimum amount of navigation sessions (an objective that can be achieved by providing the virtual multibank agent with a tabu algorithm in its design), but the user could also obtain a classification of the offers based on his/her aspirations about the product or service searched. In order to achieve this objective, we will use an intelligent agent that works without human supervision and will offer the user the result of an automatic exploration for which a visual map of the different banking offers on a certain product will be obtained, arranged according to their similarity.

The Creation of a Virtual Multibank Agent Using Intelligent Agents

Intelligent agents are programs that enable making searches using self-organizing maps in order to establish categories of terms that are used for defining or representing vectors of the web pages that will be used for establishing a visual map of the same pages placed according to similarity. Once one of the pages has been selected, the user can use this map to obtain those that are closer or more related to it.

For the search through the previous categorization of pages, we will start with a database that contains the collection of web pages corresponding to the financial institutions that operate in Spain and that offer their products and services online. In the searches using previous categorization, such classification is usually carried out manually, although there are interesting experiences of automatic classification of web pages, such as for example the WEBSOM project (http://websom.hut.fi/websom/), which uses self-organizing maps (12) in order to establish categories of terms. These categories are used for defining or representing vectors of the websites, with which it is possible to construct a visual map of the same pages placed according to similarity, by applying the same mechanism. Once one of the pages has been selected, the user can use this map to obtain those that are closer or more related to it.

In our study, we will design a virtual multibank intelligent agent that is able to provide its services to a Spanish-speaking user. The possibility of being able to expand the search method to gather multilingual data will be the subject of future research.

The objective that we propose is that the intelligent agents are able to be designed for semi-automatically processing information located on bank websites, searching for information related with that found on the pages visited by the user and with the search requirements established by the user. In sum, the intelligent agent designed will be in charge of searching for links between resources, comparing and processing Internet information for the user who requests such information, and unlike a simple search engine, it could even interact with the environment, purchasing a financial service or product, if the user wishes to do so. In which case, the agent would use protocols that enable it to work with the interfaces of these financial entities.

The first problem that we encounter when designing an intelligent agent is that the information that is handled is presented in the same format (standardization of data), so that it is possible to offer the most precise results in the most efficient manner possible when searching for or requesting information, without requiring human supervision [Semet, F.& Taillard, E. (1993)]. It has to do with converting the information into knowledge, referencing data contained on the websites into metadata, with a common layout on a given domain. As for the search system, if, for example, a system presents a significant phrase for each document searched in a list of hits, the essential information on each document can be given to the user. The advantage is that the information about a banking product is usually expressed in a very standardized language. Thus, by mentioning interest rates, the information is usually expressed in APR (annual percentage rate), NR (nominal rate), ER (equivalent monthly rate, semester, etc.); the term of the operation is usually defined as taxed term (in savings operations) or financing term (in loan operations); the capital as taxed or nominal to be financed; the commissions almost always have the same name: maintenance, opening, maintenance fees, administration, commission for early cancelation, commission for partial reimbursement, etc.

After making an exhaustive list of the main defining components of a bank product and the usual language in which it is expressed, thus converting it into categories of information, we are then ready to begin the algorithmic design of our intelligent agent, in charge of comparing data from the same category and showing results.

The Algorithmic Design of the Intelligent Agent

In the design of the intelligent multibank agent proposed in this paper, the main objective that is sought is that it contains an interface that enables questions from the users in natural language about their needs for information about a banking product and that it also responds to these questions in natural language. It also contemplates the possibility that the intelligent agent redirects the user to the address that it deems most probable as a response to the user's inquiry. It is necessary to direct the user's inquiry to the use of a few key words related to the content of the banking product about which the inquiry is made. All of the information is grouped into hierarchal levels. The belonging of these key words to each one of these levels is determined by means of a series of numeric coefficients that indicate how significant the word considered is in the level in question. With this objective, *weight vectors* are assigned to each word, with each vector containing the word's certainty or probability of belonging to each fuzzy set. The inputs to the system are the coefficients of belonging at each level (Figure 1).

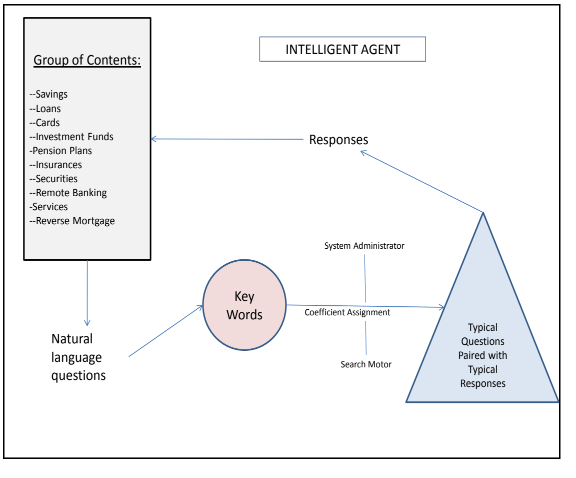

Figure-1 Basic design of an intelligent agent

The next step will be to establish a search engine that is in charge of determining the probability that the key words contained in the user's inquiry belong to a certain fuzzy set at a specific level. For this reason, the search engine takes the weight vectors of the key words as inputs. For the fuzzy logic motor, we initially chose the program Matlab, with its "toolbox" of fuzzy logic, because it is easy to use, it is possible to integrate other "toolboxes" and it is a strong tool.

The system created can have a system administrator that enables modifying coefficients of belonging in a given moment, adding new words to the database or getting feedback from the system.

By means of the fuzzy logic interference motor, we can obtain an estimate (degree of certainty) of the group of contents (characteristics of the banking product) to which the question refers and after repeating this process for all the levels of the hierarchy, such that the words with a higher percentage of belonging to a level are resent to the interference motor, that is, to the diffuse logic system; the interference motor will ultimately be in charge of determining which of the question type(s) the user's question refers, showing the corresponding responses arranged based on the probability of hit inferred and that exceed a previously determined threshold.

The interference motor implemented requires inputs and a set of rules, in order for it to give back outputs. As for the rules, we will introduce inancial calculation protocols such as the following, for example:

- Calculation of the effective APR (with commissions included)
- In the case where different interest rates are established for a same product, as occurs in the structured accounts or increasing profitability accounts, the search engine protocol will include the formula for calculating the average APR for the operation.
- In the cases where the interest rate is expressed in nominal rate or annual equivalent rate, the corresponding conversions shall be established for the APR.
- Given that in the comparison of products, we must take into account that the interest rate for the operation usually depends on the period of time, the comparison of savings products will be determined based on current values and then the amounts corresponding to the different products will be calculated at the end of their corresponding periods of time.

Given the inputs, the fuzzy sets and the rules defined, the interference motor must be in charge of calculating the output of each fuzzy system that will be related to a greater or lesser degree with the user's inquiry. The three responses corresponding to the inquiries with the highest degree of certainty would be presented to the user, arranged based on said degree of certainty. Some examples of input and output are presented below:

Key words

Question 1: I would like information about a savings product called Fixed-Term Deposit.
Response:
Indicate the amount that you would like to invest and the period of time for which you would like to invest (boxes for filling in the data).
Response: Currently, the highest profitability obtained on a fixed-term deposit is offered at Bank XXX, with an effective APR (commissions included) of Y%, for a period of Z months. Additional note: The interest is not paid in cash, but by awarding a product (television), as cash remuneration is considered to be subject to taxes on any profits from investment capital. If you wish to negotiate with the bank about the substitution of the product for cash, consult the office or the website: http://www.bancoXXX.es

Question 1: I have been offered a savings product called Growing Profitability Deposit and I would like to know if the offer is interesting or if you can advise me.
Response:
Indicate the conditions that they offered you, capital to be invested, term and interest rates

applied to each period (in the box for filling in the date, the information on the interest rate will be specifically expressed as a nominal rate or as an APR; in the same manner the period will be expressed in years, semesters, quarters, etc.)
Response: The average APR for the Growing Profitability Deposit that they offered you is Y% for a period of XX months. For this duration of time, the best offer is currently at Bank X, with an average APR of Z%.

Conclusions

The development of the work was structured into two parts. In the first part, we used the same methodology of the tabu algorithm, given that the properties of this algorithm make it ideal for optimizing navigation through websites, reducing wait times and "*noise*" (irrelevant information) in the search for information, and as a result, we achieve a decrease in the number of users who leave the site and we improve the overall quality of the navigation experience. In the second part, we created an intelligent agent that performs the task of sweeping the Internet according to the user's information needs, which not only enables the user to obtain the information in the shortest amount of time possible, but to also obtain a visual map of the different bank offers for a certain product, arranged according to their similarity.

Fuzzy Logic has proven to be a powerful tool for the design of the multibank intelligent agent described in this work, because it enables creating a database structured hierarchically by levels, according to inquiries in natural language, which yields good results. However, we are working on the application of other more sophisticated—but not less promising—tools, such as neuro-fuzzy systems.

The application of these technologies represents a contribution to efficiency in the sense that it enables facilitating and considerably simplifying the tasks of capturing, storing and processing information.

This work is currently in the programming phase, and we hope to soon be able to start the real functioning tests.

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