A WEB-BASED IMPLEMENTATION OF A PORTFOLIO ADVISOR SYSTEM BASED ON FUZZY EXPERT SYSTEMS

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ABSTRACT

Collaboration of technologies in the Internet and the field of Fuzzy expert systems have suggested new ways of sharing and distributing knowledge. However, there has been a general lack of research in the area of web-based Fuzzy expert systems (FES). This paper addresses the issues associated with the design, development, and use of web-based FES from a standpoint of the benefits and challenges of developing and using them. The original theory and concepts in conventional FES were reviewed and a knowledge engineering framework for developing them was revisited. Human in a portfolio place need an expert portfolio advisor for ask questions. Data of stock exchange is circular and portfolio advisor must update information away. The human's request is linguistic and crisp Expert System cannot solve problems completely. In my novel approach we build Web-Based Fuzzy Expert System for Tehran Stock Exchange Portfolio Advisor (FES-TSEPA) and stays in branches for recommend best sale or purchase portfolio in all of portals. This system implemented with ASP.NET 3.5, SQL-SERVER 2008.

Keywords: Fuzzy Expert Systems (FES), Knowledge based systems, Internet, Tehran Stock Exchange Index (TEPIX), TSEPA1.

1 INTRODUCTION

Knowledge based system with decision making as a tendency of study in artificial intelligence, are based in faking the behavior of human in problem solving and finding the pattern of solutions. In real world, if no certain and straight-forward solution cannot be found for a specific problem, experts are asked for help. Experts, in their way, which often includes trial-and-error methods, solve the problem. Since crisp logic can’t finds specific solution for this kind of problem, defining the method of achieving the solution for a computer is difficult. Therefore, expert systems are used to reach that goal. In these systems, the program consists of asset of a set of rules. The knowledge in human’s brain is also a set of if-then rules. There are many analytical approaches for decision making in portfolio and stock exchange, which are categorized. web-based fuzzy expert system is suggested for student educational advisor, Student’s education requests is linguistic and advisor professor receives student’s questions similar to story then inference in brain and answers to question [1]. Fair student education evaluation in exam was perused and web-based fuzzy expert system for evaluation was suggested [2]. A Web-based fuzzy expert system is proposed in the field of e-commerce [3]. Application of fuzzy expert system in Tehran Stock Exchange and select the superior stocks for investment is exhibited and some of rules in portfolio are shown [4]. Create Industry attractiveness-business strength fuzzy matrix is proposed. Rows of matrix are external factor-evaluation and column is internal factor-evaluation and inference with α-cut calculates [5]. One of the methods for receives the best estimation in Tehran Stock Exchange is study and comparison index of companies' shares from legal audit reports about 50 Top companies and evaluate the efficacy of buying the losers and selling the winners by measuring the returns to a combination portfolio that buys losers and sells winners [6]. The PROMETHEE method (preference ranking organization method for enrichment evaluation) is a multicriteria decision-making, quite simple ranking in conception and well adapted to problems method sometimes that exist conflicting criteria. Evaluation table is the starting point of this method and alternatives are evaluated on the different criteria for select the superior stocks [7]. Usually determining the linear parameters by using the

1. Tehran Stock Exchange portfolio Advisor.
least-squares algorithm and the membership function parameters are fine tuned using a neural network learning method. Initial rules are generated using the grid partitioning method. The various rule parameters during the TSK (Takagi–Segno–Kang) adaption process into ANFIS (Adaptive Neuro Fuzzy Inference System) will be fine tuned. Mainly studies the fluctuations of short-term stock prices and tries to develop a forecasting model using TSK type fuzzy rule based approach. The TSE index is selected for studies, and for more evaluation of the proposed model we test it on Tehran stock market index [8]. Project portfolio selection in the group decision support system is a three phase process:
1. pre-evaluation
2. preference elicitation
3. data analysis and reporting

This approach augments about portfolio with fuzzy integer linear programming (FILP) and finds feasible area to optimize objective function [9]. Game theory and application in decision making system is a novel model portfolio. The Stock Exchange Game Model (SEGM) with explain in Nash equilibrium. The scientific objective of this model is to test the hypothesis that stock exchange can be approximately described as a game of some players using strategies. Autoregressive Absolute Deviation model (AR-ABS) and the Artificial Neural Networks (ANN) model use in this approach [10]. In forums, usually somebody starts a discussion and expresses his/her opinions and approaches to a particular problem. Model for creating a fuzzy-based expert forum that intelligently responds to questions asked by users. Finding the right broker at the right time is another issue that requires expertise [11]. For ranking aggregate data and like with human brain inference OWA and OFD is used [12].

Current paper includes four major sections: in section 2, offers some examples of fuzzy rule-based systems and introduces the proposed model. In third section describe proposed systems are discussed. In section 4 the educational consulting expert system is discussed. Finally, a conclusion is provided.

2 LITERATURE REVIEW

Problem solving mechanism is only a small part of intelligent computer system. Thus, the necessity of expert system, a computing system capable of representing and reasoning about some knowledge-rich domain with a view to solving problems and giving advice, was increased. Usage of expert systems or knowledge-based system has extensively increased during last decade. The main difference of these systems with other software is that they process knowledge instead of data or information. Expert systems provide powerful means for solving different problems which are impossible to solve by conventional methods. Expert system is also one of the successful branches of artificial intelligence from commercial point of view. From another point of view, fuzzy set theory provides a framework for handling the uncertainties. Zadeh (1965) initiated the fuzzy set theory. Zadeh (1970) presented some applications of fuzzy theories to the various decision making processes in a fuzzy environment. In non-fuzzy set every object is either a member of the set or it is not a member of the set, but in fuzzy sets, every object is to some extent member of a set and to some extent it is member of another set. Thus, unlike the crisp sets membership is a continuous concept in fuzzy sets. Fuzzy is used in cases which there are linguistic variables. Fuzzy theory is widely applicable in information gathering, modeling, analysis, optimization, control, decision making and supervision (Bellman, 1970). Fuzzy expert decision support system is such an expert system that uses fuzzy logic instead of Boolean logic. It can be seen as special rule-based systems that uses fuzzy logic in its knowledge-base and derives conclusions from user inputs and fuzzy inference process (Kandel, 1992) while fuzzy rules and the membership functions make up the knowledge-base of the system. In other words a "fuzzy if–then" rule is an "if–then" rule which some of the terms are given with continuous functions (Wang, 1994). It is obvious that it lacks a system that can combine the advantages of the aforementioned systems. Thus, it becomes necessary to develop a decision support system which can support the procedure of stock portfolio recommendation considering the investors parameters, stock market situation and stored knowledge of the last recommendations.

2.1 QFD & OWA

Quality Function Deployment (QFD) was first developed in Japan in the early 1970s by Professor Yoji Akao and Professor Shigeru Mizuno. QFD means delivering products and services which meet the customer needs efficiently. It is a unique system for developing new products which aims to assure that the initial quality of the product or service will Satisfy the customer. QFD aims customer satisfaction. Therefore, voice of customer (VOC) Must be understood well. QFD focuses on delivering positive value by seeking both spoken And unspoken needs, translating these into actions and designs, and communicating these throughout each organization on the value chain to the end customer (Bolt and Mazur 1999). According to

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Akao, QFD is a method for developing a design quality aimed at satisfying the consumer and then translating the consumer’s demand into design targets and major quality assurance points to be used throughout the production phase (Akao 1990). American Supplier Institute defines QFD as a systematic process that helps companies quickly understand and integrate clients’ needs into their products or services (American Supplier Institute 2006). Various aggregation techniques (Nasibov and Nasibova 2003, 2005; Calvo and Mesiar 2001) can be used for combining different opinions in QFD applications. In this study it was aimed to use QFD with OWA aggregation approach to determine the needs and opinions of the university students on education and specify technical characteristics to meet these needs and opinions.

2.2 Architecture Of Fuzzy Expert System

A fuzzy expert system is comprised of four components: fuzzification unit, knowledge base, decision making logic, and defuzzification unit which should be embedded in the architecture detail for fuzzy expert system construction. The big picture of system architecture is composed of three main blocks as shown in Figure 1.

![Figure 1. Architecture of fuzzy expert system](image)

2.3 Fuzzy Inference Engine

A program which analyzes and extracts the rules and knowledge aggregated in the database and finds the logical result. There are different selection for the fuzzy inference engine depending on the aggregation, implication and operators used for s-norm and t-norms.

2.4 User Interface

Expert of this system are decision makers that enter the real number of all linguistic variables via user interface. Also, user interface shows the result scoring of all stocks. User interface of system is implemented by ASP.NET and SQL-SERVER.

2.5 Fuzzy Rule Base

Experts’ experience is used to build up the fuzzy rules. These rules are conditional statements and in general can be represented as:

If x is X and y is Y and ... THEN o is O

The x and y are linguistic variables. X and Y are equal linguistic values for x and y; respectively. They are modeled as fuzzy sets based on reference sets containing x and y: Similarly the output variable, o is a linguistic variable with a value, O modeled as a fuzzy set. The clause x is X and y is Y and ... can be interpreted as fuzzy predicates delivering partial set membership or partial truth. Consequently the partial truth of the rule premise can be evaluated, modifying the fuzzy set parameters of the output fuzzy sets.

3 FUZZIFICATION OF THE CRISP VARIABLES OF THE MODEL

The proposed fuzzy expert system aims at evaluating stocks of TSE so that make the portfolio and recommend it to the target customers at TSE according to their preferences and stocks pay off. For stock portfolio recommendation, the proposed system ranks the stocks by starting with the best one towards the worst. Ranking criteria are fundamental analysis ratios and qualitative criteria from the TSE. The guarantee risk is also combined in the ranking process. Therefore, the portfolio recommendation is accommodated to the investor’s precedence. The suitable stocks to be included in the portfolio are selected from the top of every ranking list.

The basic target of offer system is:
1. The support of the decision-investor to the procedures of ill structured decision making problems, such as the evaluation ranking of stocks/companies.
2. High level of interaction between the decision maker and the system.
3. The completed formulation of the preferences of the decision maker and the absolute specialization of his preference profile.
4. The incorporation of a huge volume of "active information" in order for the system to be always updated and to support valuable decisions.
5. Architecture that gives the possibility of incorporation of any environment of work and development.

The fuzzy expert system is intended to provide support for investment decisions regarding TSE stocks. However, it is fully parameterized and can be used in other stock exchanges, too, provided it is equipped with the respective databases. The
intention of this section is to describe the development methodology of fuzzy expert system which can propose effectiveness and efficient recommendation in TSE. The overview of the framework is shown in Figure. 1. There are seven fundamental steps in the development of a fuzzy system that consist of the fuzzy inference process.

3.1 Identification Of Critical Factors

In Iran’s stock exchange, there are several important factors can be used by experts to estimate stocks and make a portfolio of stocks. Therefore, to specify the most important factors from parcel of experts, a questionnaire was distributed between experts, investment companies, and brokerage companies working in TSE. This questionnaire had been distributed among 153 prosperous experts with the academic level in Table 1.

Table 1. The academic level of the experts who complete the questionnaire

<table>
<thead>
<tr>
<th>Academic level of Experts</th>
<th>Total</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHD</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>MSc</td>
<td>32</td>
<td>21</td>
</tr>
<tr>
<td>BSc</td>
<td>33</td>
<td>22</td>
</tr>
<tr>
<td>Experimental Business Man</td>
<td>80</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>153</td>
<td>100</td>
</tr>
</tbody>
</table>

One of these 153 experts completed the questionnaire. Then in Figure. 2 is shown the combination of the experts who were participated in the survey. Some of important factors that extract from experts are saying in follow.  
1. future projects of the company (FPC)  
2. management team reputation (MTR)  
3. Market of stocks (MOS)

Table 2. Result of experts’ scores to questionnaire with ranking

<table>
<thead>
<tr>
<th>Rank</th>
<th>Factor</th>
<th>Answer position &amp; Total of Scores</th>
<th>Mean average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MOS</td>
<td>17 19 6 7 6 8 12 10 5 7 9 12 4 11 8 7 2</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td>SR</td>
<td>13 17 8 5 9 1 10 13 9 16 4 12 11 6 3 10 5 7</td>
<td>154</td>
</tr>
<tr>
<td>3</td>
<td>EPS</td>
<td>12 10 10 9 7 16 1 7 7 11 9 7 3 10 5 3 7</td>
<td>140</td>
</tr>
<tr>
<td>4</td>
<td>FPC</td>
<td>10 6 12 4 9 10 12 6 13 16 13 4 11 9 3 1 3</td>
<td>142</td>
</tr>
<tr>
<td>5</td>
<td>SH</td>
<td>18 15 12 8 10 7 3 8 2 3 0 5 2 1 0 4 2</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>DOM</td>
<td>23 2 11 7 3 12 9 1 0 2 1 7 7 3 8 0 7</td>
<td>103</td>
</tr>
<tr>
<td>7</td>
<td>EOQ</td>
<td>12 8 10 10 7 3 8 2 1 9 8 3 8 9 1 0 5</td>
<td>104</td>
</tr>
<tr>
<td>8</td>
<td>LAR</td>
<td>10 11 7 9 7 2 7 8 3 5 5 0 6 9 2 4 3</td>
<td>98</td>
</tr>
<tr>
<td>9</td>
<td>SOFSC</td>
<td>16 6 9 1 11 3 14 0 0 8 6 3 5 9 1 3 0</td>
<td>95</td>
</tr>
<tr>
<td>10</td>
<td>LBS</td>
<td>11 3 9 13 7 8 0 1 3 5 2 1 2 7 3 9 5</td>
<td>89</td>
</tr>
<tr>
<td>11</td>
<td>HOCT</td>
<td>16 9 12 5 10 1 6 2 0 2 3 0 1 5 1 2 0</td>
<td>75</td>
</tr>
<tr>
<td>12</td>
<td>MTR</td>
<td>12 11 8 10 3 3 7 0 0 4 1 0 1 0 1 1 4</td>
<td>66</td>
</tr>
<tr>
<td>13</td>
<td>IEPS</td>
<td>10 12 5 7 1 2 4 1 0 9 3 1 0 1 2 2</td>
<td>60</td>
</tr>
<tr>
<td>14</td>
<td>WPCA</td>
<td>8 9 7 0 2 7 1 2 1 7 2 0 1 2 1 0 0</td>
<td>50</td>
</tr>
<tr>
<td>15</td>
<td>EGSOSM</td>
<td>9 5 6 2 1 0 7 1 1 0 0 0 2 3 2 1 1</td>
<td>41</td>
</tr>
<tr>
<td>16</td>
<td>SCOC</td>
<td>8 1 2 3 2 2 0 2 0 0 0 1 2 1 0 1 0</td>
<td>25</td>
</tr>
<tr>
<td>17</td>
<td>TOSD</td>
<td>3 2 5 1 0 2 0 0 0 2 1 3 0 0 1 0 0</td>
<td>20</td>
</tr>
</tbody>
</table>

Figure 2. Number of scores with mean average histogram

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4. Earned Per Share (EPS)
5. Economic Order of Quantity (EOQ)
6. direct of the market (DOM)
7. Stockholders (SH)
8. Effectiveness in general situation of the stock market (EGSOM)
9. legal audit report (LAR)
10. logical balance sheet (LBS)
11. history of company transactions(HOCT)
12. sale’s rules (SR)
13. internal and external political situation (IEPS)
14. world position and comparative advantage (WPCA)
15. size of the float stock of the company (SOFSC)
16. supplement cost of the company (SCOC)
17. trend of stockholders due (TOSD)

Experts reply to questionnaire and more important stock portfolio recommendation at TSE have been chosen. Result of ranking is ordered in Table2. If select one of answers in first position coefficient is Ratio of factors calculate with mean weigh \( \alpha_1 = 0.135 \), in second answer position \( \alpha_2 = 0.125 \), after answers:

\[
\sum_{i=1}^{17} \alpha_i = 1, \quad i = 1, 2, \ldots, 17
\]  

(1)

It was assumed that decision makers could assign ratings to different stocks under different selection criteria using common linguistic terms, for example EPS factor have a 5 linguistic term: "low", "more or less low", "medium", "more or less high" and "high". The membership functions for the importance levels are shown in Figure 3.

![Figure 3. EPS factor, Fuzzy membership functions](image)

### 3.2 Rule Generation

After an interactive negotiation with experts, the obtained data are fuzzified. The previous section illustrates how any of stock exchange indexes can be fuzzified. For example following fuzzy rule is the result of the negotiations with experts:

\[
\text{If} \\
\text{The MOS is Medium And} \\
\text{The SR is Low And} \\
\text{The EPS is High And} \\
\text{The FPC is more or less more And} \\
\text{The SH is low And} \\
\text{The DOM is medium And} \\
\text{The EOQ is low And} \\
\text{The LAR is good} \\
\text{Then} \\
\text{Selling the many of this stock is good.}
\]

### 3.3 Data Centralization

If the profiles of users are available in a centralized storage device, user can see the before necessary data and system can provide the better answer by directly accessing a users’ profile.

With development of the World Wide Web and applying multimedia tools along with the accessibility of web sites from any place in the world makes it feasible to design the user interface compatible with the web. Many expert systems in different fields of expertise are developed (EXSYS CORVID, XpertRuleKnowledge Builder,...) but few are applied. Since linguistic terms and fuzzy sets are used, the process for inference should be done on the client rather than the server so the server’s busy time is reduced. This procedure can be done by using browser executable languages like JavaScript, VB Script, XML, AJAX, Silverlight and Applet.

### 3.4 Cosidering The Exclusion Issue Of A Portfolio Users

Before selecting the stock for the buy or sell, the stock purchasers or vendors are checking the mart and search for best selective stocks for transaction, should be excluded are determined and prevented for buy or sell in treatments. The portfolio’s advisor should address his/her issue according to bourse rules and regulations. Below are shown some questions and answers asked and answered by advisor or inference in brain (respectively).

### 4 PROTOTYPE INSIDE THE SYSTEM

My web-based portfolio fuzzy expert system build on 6-tier and have a best performance on the web, in Figure 4 framework of system is shown. Implementation web application has these sections:
1) Interactive User Interface: get and send crisp values.
2) Look categorized fuzzy sets equal user input crisp values same EPS, MOS, SR, and so on from DB.
3) In crisp system variables is fuzzed and generates linguistic variables with suitable membership function. This section achieve by one user defined function on the DB, by name Udf_Fuzzification.
4) Linguistic variables send to inference engine and process with mamdani and Sugeno model [5]. This section execute by one stored procedure in database, by name Stp_Inference.
5) Fuzzy results defuzzify and output crisp values generate, this section accomplish by one user defined function in database, by name Udf_Defuzzifier.
Finally advisor system evicts answer to user.

5 PROTOTYPE INSIDE THE SYSTEM

Software has 6 layers and is shown in Figure 5:
1) Web application layer include: web pages, functions, enumerations and LINQ objects.
2) Business facade, business rules layer includes: Business classes and methods for control and modeling entry data. List of classes are:
   i) FuzzyDecision Class
   ii) FuzzyNumber Class
   iii) FuzzyPattern Class
   iv) FuzzyRuleInference Class
   v) FuzzySet Class
   vi) FuzzyWord Class
3) Security layer for keeping privacy user data in web, and control all of vulnerability and treats then countermeasures include: “XSS”, “Sniffing”, “Session Hijacking”, "Denial of Service (DoS)” and “Sql injection”.
4) Data access layer that is one Built-in interface class, by name: DataAccess and support ADO.NET and working connectionless completely.
5) Web Service Data injector from TSE site in periodic times.
6) Database objects include: Stored procedures, User Define Function, Views and CLR functions. In database engine scheduled resources with resource governor for allocation resource to users with policy.

6 RESULT

The major advantage of these systems is that knowledge gradually turns into wisdom and can be used as a decision making tool in critical situations.
which replaces the conventional FAQ. Some other features are:

1. More accessibility: Many experiments can be done. Simply an expert system is a mass production of experiments.
2. Cost reduction: The cost of gaining experience by the user is decreased considerably.
3. Risk reduction: The expert system can work in environments dangerous, harmful or unpleasant for human.
4. Eternality: These systems don't die.
5. Multiple experts: An expert system can be the result of knowledge elicitation of several experts.
6. Reliability: These systems don’t get tired or sick, they don’t go on strike and they don’t conspire against their managers. On the contrary, these are often done by experts.
7. Explanation capability: An expert system can explain the way in which the results are obtained. On the contrary, due to many reasons (fatigue, unwillingness, etc.) experts are not able to provide such explanations all the times.
9. Responsibility in any condition: In critical conditions and/or emergencies an expert may be unable to make the right decision due to stress or other factors while an expert system’s decision making is not affected by these events.
10. Experience base: An expert system can provide access to a massive amount of experience.
11. User training: An expert system can act like an
12. Intelligent tutor: problems are presented to the system and the way of reasoning can be obtained.
13. Ease of knowledge transmission: one of the most important advantages of expert systems is it is convenient to move the knowledge of the system somewhere else on the globe.

7 CONCLUSION

In the beginning of this paper a glance to definitions and introduction to fuzzy logic and fuzzy decision making was taken. Then, some implemented examples of such systems are presented and finally, a web-based portfolio consulting expert system is proposed. In the end, the capability of the system in enhancing the consulting process is shown.

APPENDIX A. TEPIX

Tehran Stock Exchange has evolved into an exciting and growing marketplace where individual and institutional investor trade securities of over 420 companies. TEPIX is a weighted market value all share prices appearing on the TSE Price Board. TEPIX calculation method is as follows:

$$TEPIX = \frac{\sum P_i \times C_i}{\sum P_i} \times (Base – Value) \quad (2)$$

Where $P_i$ and $P_{ib}$ represent share price of company $i$, respectively at time $t$ and at the close of trading on March 21st, 1990; and $C$ shows the total number of shares at time $t$. And other important index in this market contains Industrial Index, Financial Index, Top 50 Companies Index.

REFERENCES


