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A Framework of the Web-Based Knowledge Management Agent for Financial Decision Support System*

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〈목 차〉

Ⅰ. INTRODUCTION

Recent telecommunication and network technologies have brought a lot of changes, especially in decision pattern in businesses. Networking revolution makes a user quickly access to virtually any computing machine, database, repository, and facility wherever it locates. Instant accessibility and ubiquity brought by telecommunication and network development, web-technologies in particular, create many opportunities as well as some problems (Ahmed, 2002; Sycara, 1998; Wang, 1997; Maes, 1994).

Digitalized, ubiquitous, global surrounding and more competitive business environment need faster loop of information feedback, meaning that in today's competitive business, timely information delivery is a more than desired attribute (Faught, Green, and Whitten, 2004). In the past, business information

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emphasizes accuracy attribute while in the Internet era, most information is time-stamped, and providing timely information to managers is a critical success factor to business(Dibrell, Davis, Danskin, 2005; Davison, Li, and Kam, 2006; Faught, Green, and Whitten, 2004).

The purpose of this study is to design and implement software agents to support such fast - tracking decision-making situation. Our software agents are designed for one of the key financial market sectors-credit rating system, a key financial infrastructure for the banking and financial areas. We propose a multi-layered framework for developing and organizing knowledge-based for credit rating agents. Special features of these rating agents are, foremost, designed to provide a "fast rating opinion with reasonable accuracy" while the traditional rating approach emphasizes the "accuracy" of rating principle.

Ⅱ. LITERATURE REVIEW

2.1 Web Surveys

Over the years, artificial intelligence (AI) tools and techniques have been frequently used in financial applications, including, bond rating(Lee et al. 2005), bankruptcy prediction (Lee et al., 2005; Tom and Kiang, 1992), stock portfolio selection (Lee et al., 1989), and auditing (Lenard et al., 1998). Many of these early AI applications have met with limited success because of their stand-alone feature.

Due to telecommunication revolution, web-technology in particular, we can have interactive relationship among many market participants. Applying this concept to the cyberspace, we have a virtual market place such as e-market place, online shopping mall, etc. We also can do some web-based surveys or get some opinion through worldwide(Grace-Farfaglia et al., 2006; Davison, Li, and Kam, 2006). Web-based surveys or web-based polls have propelled new growth for market research as well as government and academic research (Davison Li, and Kam, 2006; Granello and Wheaton, 2004). Web-based surveys offer significant advantages over traditional stand-alone paper-based surveys, not least in terms of cost and time: once an instrument system is setting up, we can use the system over and over time or we may build consensus on specific events through an interactive fashion (Evans and Mathur, 2005; Grace-Farfaglia et al., 2006). The connectivity given by web, coupled with AI application would provide a standard platform that a variety of different expert advices can be shared with the public. One such application area may be credit rating (Lee and Madey, 1998).

2.2 Credit Rating System

A credit rating is an ongoing judgment (or opinion) process of experts about the future creditworthiness of a debt issuer (Stimpson, 1991). Bond rating activities play a significant role as a key financial infrastructure sector: an instrument that influences the distribution of market fund for issuing companies. For issuing companies, the ratings affect the level of interest they can get from such funds. This interest will in turn distribute to the investor. Therefore, bond ratings serve as an important investment as well as distribution vehicle showing different risks and earning levels for the financial community.

This expert judgement for a specific bond is qualitative nature mainly due to its future orientation, and the role of the quantitative analysis is to help make the best possible judgment (Kim and Lee, 1996; Nour, 1994; Stimpson, 1991). The bond rating situation poses a typical classification problem: transformation of domain information and data (inputs) into rating symbols (outputs) through interpretation of experts (processes) (Lee and Madey, 1998).

Recent financial markets are extremely vulnerable with information overload: market participants have to sort out a vast amount of data, information, company reports, daily newspapers, etc., to make a better judgment (Maes, 1994).

Tremendous amount of data and information captured by each and every millisecond around the world pouring down to users quickly overwhelm the user's cognitive capabilities, the phenomenon known as information overload. Thus, a user without appropriate decision support tools digress easily, tire quickly, and therefore fail to do appropriate actions or unable to make desired decisions oftentimes. Such unaided decision making processes, yet, clearly fall far behind of the virtual speed of information flows needed in the Infosphere.

That is why we provide this web-based credit rating agent for the bond market, the key financial market infrastructure.

Ⅲ. RESEARCH DESIGN

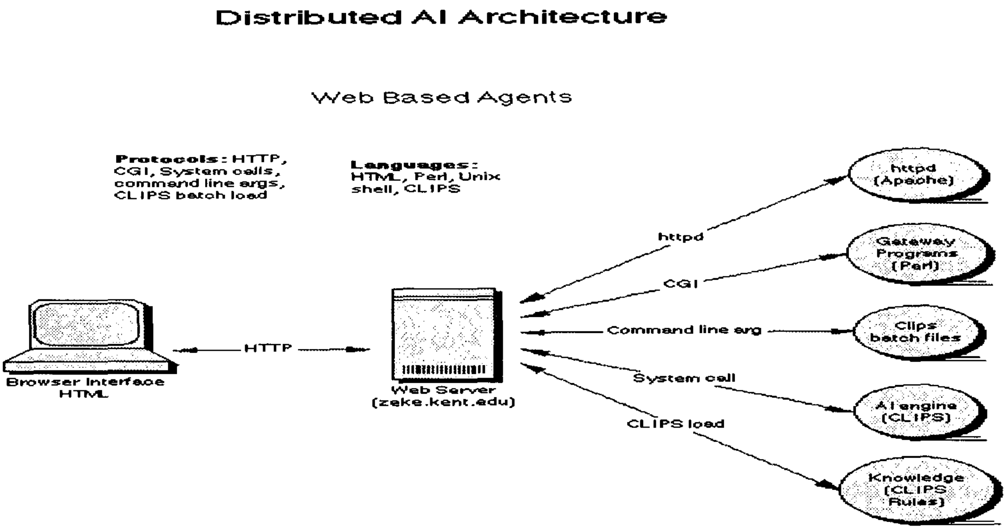
3.1 Web-based Credit Rating Agents

We provide the design and development process of the web-based credit rating agents (WCRA) that provide intelligent advises of evaluating creditworthiness of a bond issuer quickly over any geographical area. In this section, we first emphasize the distinctive characteristics of WCRA. Then the next section, we detail the architecture of the web agents.

The client and server architecture, coupled with telecommunication developments, makes it possible to overcome spatial distance so that WCRA provides instant advices, any time, any where (Evans and Mathur, 2005; Healey, Macpherson, and JUijten, 2004). Thus, response time to new financial information would be minimized and a user can assess to the expert opinions and updates her knowledge base as quickly as possible. The user can also save her rating results and retrieve them a later usage. Doing so, the decision tools provide a way of ongoing rating approach rather than a spot approach which is usually done in the past research effort. Others can also assess the previous rating results done by someone else. For example, agent cooperation among human experts via this web expert-system agent is accomplished by accessing previous rating information by others. This high-level agent cooperation is the essential component of the web bond rating agents.

3.2 Architecture of Web-based Credit Rating Agents(WCRA)

<Figure 1> shows the architecture of the WCRA. The agents are consisted of three major components: a) a user's interface, b) gateway agents that provide connectivity between the user and the credit rating experts, and c) the rating knowledge-based system that is organized in a multi-layered framework explained later. The first component, the user interface controls interaction with potential customers. It contains screen displays, questioning strategies, and an explanation component. In our rating system, the web-technologies are being extensively used for this purpose. Besides an easy-to-use multimedia browsing function, web provides a genetic role of connection. Here we have two connections linked by the web; one connection between a browser and a server; the other connection between the server and an expert system shell through gateway agents. We use PERL language to design Common Gateway Interface (CGI) to invoke the connection to the expert's knowledge bases. The web server uses the Common Gateway Interface to execute the expert system shell that obtains the dynamic information, format it into HTML, and forwards it to the Web server which will forward to the browser using HTTP protocol on the top of TCP/IP protocol suite. The third component, the knowledge-based system is embedded in CLIPS rules and the multi-layered knowledge representation scheme. CLIPS (C Language Integrated Production System), a multi-paradigm programming language that supports rule-based, objective-oriented programming environment, is used to capture knowledge bases of experts. The inference engine contains mechanisms, strategies, and controls used to manipulate and apply



<Figure 1> Architecture of Web-based Credit Rating Agents

knowledge to the specific problem given. <Figure 1> summarizes technologies that the intelligent bond rating agents employ. The protocols that the intelligent bond rating agents use are HTTP, CGI, System calls, etc. Languages being used are HTML, PERL, UNIX shell scripts, and CLIPS.

Ⅳ. IMPLEMENTATION OF WCRA

4.1 Knowledge Representation

The knowledge-base system of credit rating agent is represented on three categories of measurements: industry, management and financial. First two measurements, industry and management categories, two qualitative consideration, are supplemented onto the conventional credit rating knowledge representation approaches. The industry variable is included because: 1) industry characteristics identify industry participants and major players within the market, provide benchmarks, 2) thus understanding industry characteristics is important in explaining industry competitiveness. In fact, these three variables are often used in credit rating officers in practical fields (Healey et al., 2005; www.creditrating.com)

Management variable is another qualitative group factor included in this agent's knowledge representation design. While an industry factor provides who to be compared for the company, management factor provides an information about internal environment of the company, such as vision, philosophy, tacit knowledge, culture, etc, mostly not reflected in financial performance of a company. Financial measurement usually does not capture these kinds of information. Management factor also gauges issue-specific events such as maturity of bond, because this kind of decision making are largely depended on management jurisdiction.

As mentioned earlier, financial measurement provides a rather objective data of the past operating records. This financial factor is to measure relative financial strength of a company. Two typical approaches employed to measure financial strength are ratio analysis and trend analysis. We compare each measurement of an issuer with their benchmark such as industry leader, peer groups, or industry average. Following this approach, we do not need to use some theoretical cut-offs that are rarely true in the practice.

Following are the detail knowledge representation and capturing areas of this web-based credit rating agents.

1. Industry competitiveness (ten factors) - life cycle stage of industry, profitability of industry, market position of firm, technology competitiveness, stability of industry structure, price competitiveness of firm, niche market possibility, research and development state, business cycle, flexibility.

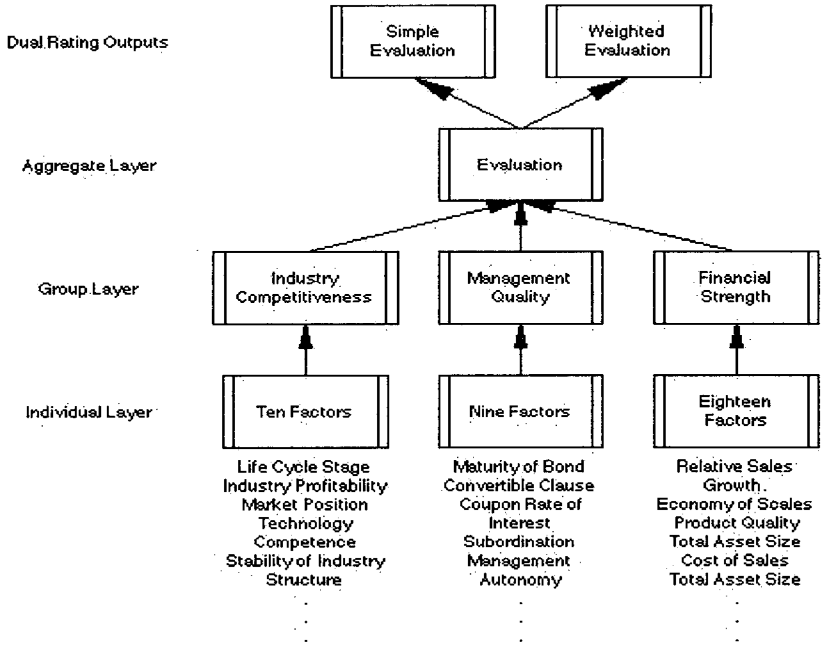
2. Management quality (nine factors) - maturity of bond, convertible clause, subordination, coupon rate of interest, management autonomy, management succession, creative culture, balance of policy, compatibility of management.

3. Financial strength (eighteen factors) - relative sales growth, sales growth rate, economy of scales, product quality, improvement of product quality, total asset size, ratio of sales to net income, cost of sales, appropriateness of accounting procedure, ratio of sales to interest payment, appropriateness of investment, cash flow/total debt, quick ratio, liquidity ratio, inventory turnover, sales turnover, equity/debt, trend of equity to debt.

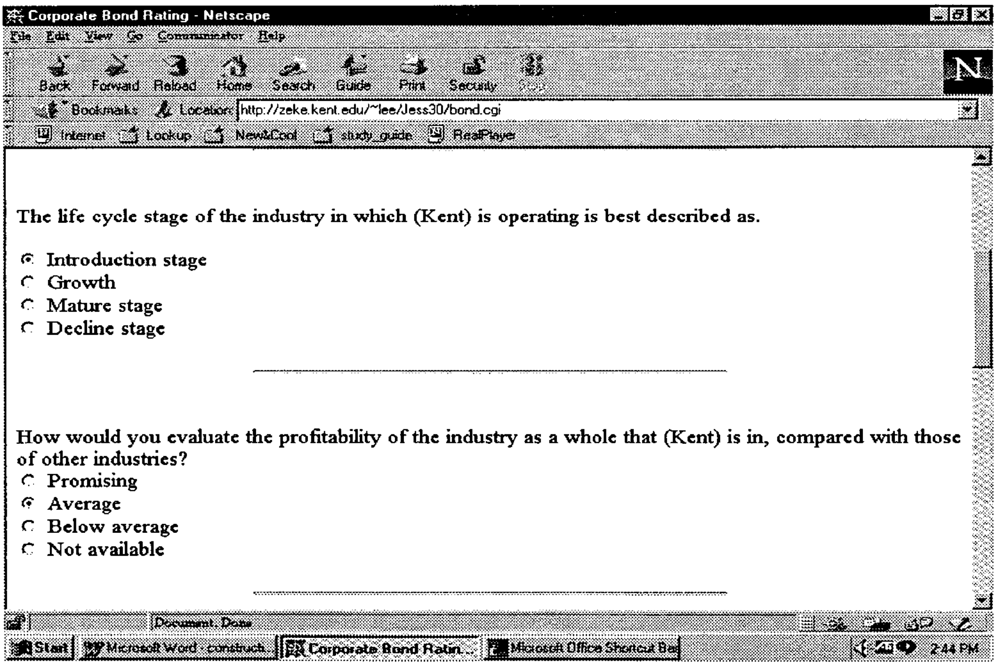
4.2 Representation Transformation

The framework for KBS (knowledge base system) of the credit rating agent is organized into three layers—individual, group, and aggregate layers. This multi-layered knowledge representation framework, adopted from Suh and Madey (1997), is shown in <Figure 2>.

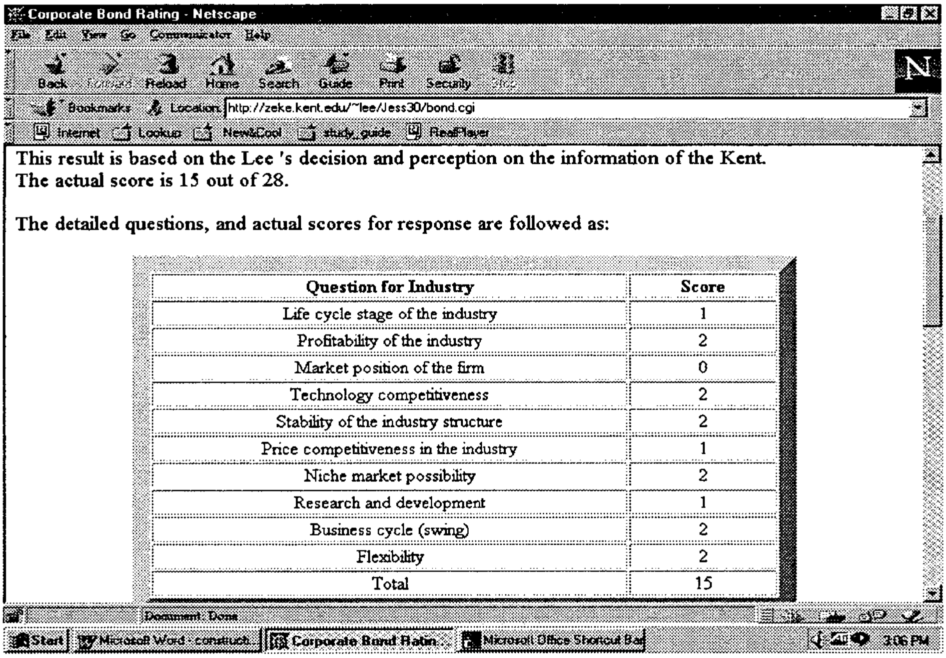
The individual layer receives a user's response. <Figure 3> shows the user interface of industrial competitiveness questionnaire. Each response to an individual layer is weighted and then is summed at the group layer. The sum of a user's responses



<Figure 2> A multi-layered framework of KBS



<Figure 3> Industrial competitive questionnaire



This result is based on the Lee 's decision and perception on the information of the Kent.
The actual score is 15 out of 28.

The detailed questions, and actual scores for response are followed as:

Question for Industry	Score
Life cycle stage of the industry	1
Profitability of the industry	2
Market position of the firm	0
Technology competitiveness	2
Stability of the industry structure	2
Price competitiveness in the industry	1
Niche market possibility	2
Research and development	1
Business cycle (swing)	2
Flexibility	2
Total	15

<Figure 4> the evaluation of Industrial Competitiveness

will be translated into one of four classes – superior, good, average, or poor. Explanation for each group evaluation is provided. For example, <Figure 4> illustrates the industrial evaluation result of a firm and its explanation. This group information in turn feeds into the aggregate layer where the previous information is classified into 7 different bond rating classes – AAA (extremely strong), AA (very strong), A (strong), BBB (adequate), BB (speculative), B (speculative and uncertain), CCC (poor) – depending on 64 combinations of evaluation values (4 values for each group and 3 group factors: 4×4×4=64).

The aggregate layer then presents the user with a rating class and its explanation. This is a simple-weighted result that is based on combination of the group sums. In fact the simple-weighted rating or the simple rating evaluation gives equal weight to the three group factors when aggregated. This categorized point scale is subject to the programmer's subjective decision rule and this can be further improved if some weighting scheme is used to decide on the decision rule gather from a number of different users. For this purpose, this agents also provide an additional functionality at the aggregate layer in that the user can assign different significance, a user's preference, to the group sum.

At the aggregate layer, the user can assign his/her preference factors using different subjective attachments to the group sum. First, the expert system asks the user's relative significance of each group factor (i.e., industry: management: finance = 20%: 30%: 50%). And then an aggregate score is provided. The maximum aggregate score is 100. For example, if an aggregate score is 82 the user may assume some range of values for rating, together with a simple-weighted result.

V. CONCLUSIONS AND FUTURE RESEARCH

We design a skeleton model of decision supporting tool in the field of industrial bond rating system hoping that it provides timely response to new information, a crucial information attribute in the new information age. By using web-technologies, stand-alone knowledge can be linked to the information highway. A multi-layered framework for capturing domain specific knowledge that can be used for some related fields such as municipal bond rating or sovereign rating areas is presented. Besides, deployment of these web technologies in some other time-demanding financial applications (stock portfolio, bankruptcy prediction) would be benefit for the capital market in general. In sum, these prototypical web agents provide instant responses to new information, overcoming any spatial and time difference.

Some of limitation of this research are as follows:

First, selection of knowledge representation in terms of industrial, management, financial and their associated magnitude in the program are somewhat arbitrarily decided. Future research may improve this by introducing a list of measurement selection choices to the users and by launching an empirical artificial intelligence research such as neural networks to measure strength of input-output mapping for each of knowledge variable.

Second, deciding weight factor at the aggregate layer is solely depended on the user's choice at the current program. The user can improve her preference over time, however, as she can accumulate the previous results of a specific company. We hope that this accumulation of the weighting factor of a company over time may narrow down the range of the weighting factor for the company.

Thirdly, in this paper we identify timeliness attribute of information as a crucial information feature in this coming information age. We do not investigate further into find other crucial information attributes in this network epoch. However. it is desirable to identify some crucial information attributes for this information age.

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서강대학교 경영학과 졸업, Maine 주립대에서 경영학석사와 Kent 주립대에서 경영학 박사를 취득한 후 현재 인천대 경영학부 MIS전공 교수로 재직 중이다. 한국신용평가 연구원으로 근무한 바 있으며, 관심분야는 인공지능을 이용한 재무패턴 인식, 정보보안, eSCM 등이다.

<국문초록 >

웹 기반 금융의사결정지원시스템 프레임워크 설계 및 구현

박정희 · 이기동

최근 정보기술(IT; Information Technology) 및 네트워크 기술의 발달은 기업사회의 의사결정 패턴에 큰 변화를 주고 있다. 특히 글로벌 정치경제 환경이 급변함에 따라 기업들의 의사결정은 보다 빠른 피드백(feedback loop)을 요구하고 있어 과거의 정확성을 중심의 패턴에 변화된 정보의 시기적절성(timely information)이 크게 강조되고 있다. 본 논문에서는 이러한 첨단기술사회에서 빠르게 의견수렴을 할 수 있는 기술적인 프레임워크를 구축하였다. 본 시스템은 현대사회의 주요한 경제 및 재무의사결정 구조(infrastructure)인 신용평가(credit rating)제도를 웹 기반 시스템으로 구현함으로서 정보의 시기적절성과 현재성을 높이는 의사결정지원시스템을 시현하였다.

Keywords : 웹기반 시스템, 정보의 시기적절성, 신용평가

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