PREFACE: The Evolving Paradigms of Artificial Intelligence and Expert Systems: An International View

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Artificial intelligence (AI) paradigms have reached a level of maturity in which various techniques have proven to be successful. The great potential for accounting and finance research has been shown in a variety of research projects ranging from the study of decision-making behavior to the emulation of the cognitive processes of the human experts. Other successful AI projects studied the development of descriptive theories of reasoning, the use of formal languages for representing accounting knowledge, the discovery of patterns and relationships among data, and the use of noisy or incomplete data.

Among the main evolving AI paradigms are: decision tree induction, genetic algorithms, artificial neural networks, and case-based reasoning. All of them can potentially provide some kind of knowledge discovery mechanisms and all have been applied in accounting and finance in the international arena.

With a decision-tree induction system, accounting researchers can construct knowledge by collecting previous cases solved by experts, identifying the attributes that may have effects on the decision, and executing a role induction program that provides a set of roles and/or a decision tree. The main advantage of these systems *is the clarity of the decision tree as a* descriptive model of the knowledge buried in the data. Limitations include a low capacity for generalization and an incapacity for dealing with incomplete examples.

Neural networks are used mainly where decision-makers have to deal with incomplete, imprecise, ambiguous or irrelevant data that require a more subjective analysis. In these decision environments, neural networks offer clear advantages over expert systems due to the generalization capacity given by their adaptive structure. Neural networks are effective in pattern-learning where imprecise or contradictory data exists. Their capacity for generalization/prediction overcomes that of other techniques, both statistical and artificial intelligence. Their main limitations are their scarce explanatory capacity and the complexity and effort it takes to design a generalizable network architecture. Consequently, neural networks are suitable for applications requiring noisy or incomplete data, in tasks where no experts exist or where clear links can not be formulated. Obviously, neural networks are not recommended where the explanation of reasoning is a critical factor.

Genetic algorithms have been applied to the financial field both as an efficient technique in problem-solving that finds optimum values for parameters, and as role-learning mechanism. Their strength centers around their capacity to produce improved solutions to the problems to be solved, breeding many generations of solutions. From each generation, only the best solutions survive to have an impact on the next. From a role-learning approach, genetic algorithms have proved to be highly efficient in searching for large data sets, being able to learn the relationships among them, even in the presence of incomplete or contradictory data. For this reason, they can be used, as data-mining tools, to discover unknown patterns.

While expert systems codify deductive reasoning chains that constitute the general strategy of problem solving, case-based reasoning systems (CBR) retrieve the relevant experience

(facts-historical solutions) that the company may have in dealing with similar cases. CBR applications improve their performance by adding more cases to the system. This enables the program to learn from experience. CBR systems are suitable in dealing with applications based mainly on experience gained from former situations.

Many applications function more effectively using a hybrid systems approach. Hybrid systems combine two or more techniques in order to overcome the individual limitations of each one. Hybrid systems that combine neural networks and genetic algorithms are capable of realizing the design and development of many neural networks that would normally be realized using manual methods of trial and error. Some of these tedious tasks include the selection of data sets for testing and training the network, the determination of input variables and the selection of a determined architecture. Some hybrid systems use genetic algorithms to develop neural structures and to choose fundamental input variables so that the neural network succeeds. This capacity for evolution, learning and adaptation constitutes a powerful paradigm for problem solving. Another benefit of the use of hybrid systems is that of the requirements of the problem to be solved. That is, many problems can be broken down into sub-problems, each of which can be particularly suitable for a determined technology. For example, a problem involving tasks of prediction, optimization and reasoned explanations can be solved by a hybrid system that incorporates a neural network, a genetic algorithm and an expert system, all of which deal with each sub-problem. The different modules would combine their results so as to achieve a final solution. Gocoatilake and Khebal (1995), have named these kinds of systems: *inter-communicating hybrids.*

The aim of this book is to provide an international perspective of the types of artificial intelligence research being undertaken in accounting and finance. It mostly contains a collection of papers which were presented at the 2nd and 3rd International Meetings on Artificial Intelligence in Accounting, Finance and Tax, held in Punta Umbria (Spain) in 1996 and 1997, as the mid-year international conferences of the AI/ES Section of the American Accounting Association. Most of the above paradigms, as well as fuzzy logic, intelligent agents, and natural networks applications, are represented here. **The book is divided into five parts:**

1. Introduction
2. Accounting Applications
3. Finance Applications
4. Case-Based Reasoning
5. Surveys

In this first part we briefly review some of the key features of the main AI paradigms being used and describe the papers in the book and then M. Vasarhelyi examines the evolving scenarios of data processing, networking, financial reporting, assurance services and electronic commerce. Subsequently he proposes a series of new views on corporate reporting and assurance by using new technologies and Al techniques that can potentially provide some form of intelligence decision making.

The second part focuses on accounting applications. Brown and Sangster discuss the applicability of the Perrow framework to the classification of management accounting tasks for expert systems development. Siebdrat and Baldwin show how the concepts of BPR (Business Process Re-engineering) can be integrated with expert systems to re-engineer accounting processes, and how new concepts of object orientation, workflow and the internet are evolving to impact the design of business processes. Ramamoorty, Traver and Bailey describe the preliminary development of a neural network model of risk assessment in internal auditing. This research

project, sponsored by the University of Illinois and the Institute of Internal Auditors' Research Foundation, aims to evaluate whether neural networks pattern recognition capabilities can help enhance risk assessment performance. Vasarhelyi and Hoitash conclude this part of the book by surveying the current state of intelligent software agents through examining various tasks in which intelligent software agents can benefit finance and accounting information systems.

The third part presents a set of papers describing financial applications. Larvor´s paper exposes the stages of a knowledge based system design, jointly developed by Credit Mutuel Bank and Artificial Intelligence and Cognitive Science Laboratory of Bretagne (France). The system automates the reading and banking processing of SWIFT (an international network in which banks communicate) financial messages. Collier and Leech present a descriptive model of insolvency decisions (MIND) using an expert systems research approach as articulated by Bailey et al. (1987). MIND combines process models with a set of hierarchical weighted-additive methods. In a process model, a judgment can be made directly or can be assessed by using a weighted-additive combination of the subsidiary factors that may be combined to make this judgment. Costantino, Collingham and Morgan describe a system, under development at the University of Durham (UK), to automate the extraction of financial information from text documents. The system, based on natural language processing techniques, summarizes financial news producing specific templates associated to the various financial activities (company related, company restructuring and general macroeconomic). The templates produced from the source text can be used for reducing the data overload suffered by traders, brokers and other financial operators and can also be used for a "meta analysis" of the effects of news on price behavior. Greenstein and Welsh assess the viability of a neural network bankruptcy prediction model by using realistically proportioned testing sets. The study also examines whether the neural network models are relatively static or dynamic over time. The Quesada paper reports on Lekta II, a research project being developed by Telefonica I+D and the University of Seville (Spain) that aims to provide a bi-directional English-Spanish machine translation prototype in the banking domain. McKee discusses the development of a fuzzy logic bankruptcy prediction model using a sample of 200 public companies (50% of which were defined as going-concerns). Back, Laitinen and Sere compare neural networks with discriminant and logit analysis in bankruptcy predictions. The study shows whether changes in sample size affect the

prediction accuracy of the methods as well as which method is best. In the final paper of this part, Dizdarevic, Larrañaga, Sierra, Lozano, & Peña present the application of methods from the area of Machine Learning, and Statistics to the problem of the corporate failure prediction. A sample of 120 Spanish companies, 60 of which had gone bankrupt, and 60 had not, are used. Statistical methods: Discriminant Analysis, Logistic Regression, Classification Trees, Rule Induction and Bayesian Networks as well as two Artificial Intelligence techniques - Voting by Majority Principle and Bayesian Formalism -, are implemented. The predictor variables that gather the accountant information taken for every company over the three years previous to the date of survey are financial ratios. The results show an interesting comparison of methods and results.

In the fourth part of the book, three papers describing case-based reasoning applications are included. Morris and Sinha examine three CBR systems aiming to identify the task features that make CBR an appropriate model. The paper compares CBR techniques with expert systems and neural networks, trying to provide a first step in the development of a framework for choosing among these methodologies. Mulvenna, McIvor, Ward and Hughes discuss a hybrid (rule based, CBR and statistical) prototype model designed to help in financial strategic decision-making, particularly the interpretation of financial data for acquisition analysis. Curet and Jackson present a CBR system to assist in top management fraud detection. The objectives are threefold: (1) to examine new design methods for CBR applications, (2) to identify the extent to which CBR can enhance the decision-making and (3) to evaluate the suitability of CBR for other applications. Mulvenna Mcivor Ward and Hughes demonstrate how case based reasoning technology can assist in the interoperation of financial data for acquisition analysis. Their prototype incorporates rule based and case based reasoning technologies to assist companies in making effective acquisition decisions. They demonstrated that it is realistically feasible to use a knowledge based systems methods to build hybrid decision support systems in the area of financial strategic decision making. Finally, Curet and Jackson study the application of case based reasoning as a tool that assists accountants in identifying top management fraud.

The last part of the book contains one article that surveys AI research in accounting and finance in Spain. The paper by Bonson and Escobar presents an overview of AI research over the last 17 years (1986-2002). The paper examines the type of research work, the tools and techniques that were utilized, and the type of problems/domains that were studied by AI researchers. The authors showed that AI research was growing at a fast pace during the 90s. The paper documents that most of the AI research was produced by a relatively small number of research institutions, and that expert systems and neural networks were the leading AI techniques studied by researchers.