



Review Article

Artificial neural networks in business: Two decades of research

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ABSTRACT

In recent two decades, artificial neural networks have been extensively used in many business applications. Despite the growing number of research papers, only few studies have been presented focusing on the overview of published findings in this important and popular area. Moreover, the majority of these reviews were introduced more than 15 years ago. The aim of this work is to expand the range of earlier surveys and provide a systematic overview of neural network applications in business between 1994 and 2015. We have covered a total of 412 articles and classified them according to the year of publication, application area, type of neural network, learning algorithm, benchmark method, citations and journal. Our investigation revealed that most of the research has aimed at financial distress and bankruptcy problems, stock price forecasting, and decision support, with special attention to classification tasks. Besides conventional multilayer feedforward network with gradient descent backpropagation, various hybrid networks have been developed in order to improve the performance of standard models. Even though neural networks have been established as well-known method in business, there is enormous space for additional research in order to improve their functioning and increase our understanding of this influential area.

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1. Introduction

Artificial neural networks are computational structures designed to emulate the accumulation of knowledge in the biological central nervous system. Contrary to conventional computational techniques, they are able to solve nonlinear and ill-defined problems based on parallel composition. In last two decades, the utilization of artificial neural networks has largely increased in the field of business. This evolution has not only led to development of many different scientific applications, but also to intensive exploration of practical issues. The characteristics of artificial neural networks such as efficiency, robustness and adaptability make them a valuable tool for classification, decision support, financial analysis or credit scoring. Their success can be clearly demonstrated by a growing number of publications in prestigious journals.

Employment of neural networks in business, finance, or management has been reviewed by several authors from various points of view. Wong et al. [408] focused on neural networks business applications and surveyed 203 articles published during the period of 1988–1995. They categorized the available literature according to 12 categories, namely the year of publication, application area, means of development, etc. Wong and Selvi [407] concentrated on financial applications and reviewed 64 articles introduced between 1990 and 1996, concluding that the most applications have been published in bankruptcy prediction and stock performance forecasting. On the other hand, Vellido et al. [388] aimed in their study at applications related to management, marketing, or decision making and avoided financial uses such as bond ratings, derivatives, stock markets as well as macroeconomic predictions. Smith and Gupta [350] presented interesting developments in the use of artificial intelligence for the operations research problems. They emphasized the various types of neural network models which are applicable when solving business problems. Wong et al. [409] reviewed neural network application research in business between 1994 and 1998, stating that due to accessibility of raw data and overall complexity, financial applications could be one of the most common neural network research areas in the future.

Writing a comprehensive survey of business, operational, or manufacturing applications of neural networks would be demanding due to the extent of studies and their number. The purpose of this research is therefore to provide a review of the recent neural networks research purely in business. Various disciplines have been investigated, including accounting, costs monitoring, customer analysis, finance, marketing or sales. Articles dealing with manufacturing, process optimization, engineering or operational research have not been included. The study highlights the importance of this artificial intelligence method and provides description of recent research for both academics and practitioners. Our review not only emphasizes the historical progressions in the field of neural networks, but also discusses the prospective development in the neural network research in the examined area.

2. Research methodology

To identify relevant journal articles dealing with neural network applications in different areas of business we searched EBSCOhost, Google Scholar, JSTOR, Science Direct, SpringerLink, and Wiley Online Library databases for the period of 1994–2015 using combinations of keywords “neural networks” and “business”, “finance”, “corporate”, “stocks”, “capital”, “costs”, “financial analysis”, “accounting”, “bankruptcy”, “exchange rates”, “financial distress”, “inflation”, “marketing”, “customers”, and “bonds”. After search through the databases we performed an additional exhaustive review of all 125 identified journals.

We followed the modified criteria given in [409] determining that each article should introduce the utilization of neural network in given area and should have detailed description of the network type and learning algorithm. Every article had been carefully reviewed before it was incorporated into the survey. A large number of publications had not been included because given applications had primarily system design, operational, or engineering characteristics such as facility layout problems [45,380], intelligent manufacturing [25,39,150,345], job-shop scheduling [196,252], or process identification [14,256]. Each article was classified according to seven categories:

1. Year of publication.
2. Application area.
3. Type of neural network.
4. Learning algorithm.
5. Benchmark method.
6. Citations.
7. Journal.

It is essential to emphasize that the results of this review definitely do not include all applications of artificial neural networks in business and are based purely on information acquired from mentioned databases and identified influential journals. Working papers, conference proceedings unpublished in reputable journals, and non-English journals were not part of the study.

3. Results and discussion

We have identified a total of 412 suitable journal articles which presented appropriate artificial neural networks applications in various business disciplines. References [37,70,80,331,350,388,407–409] provided surveys of the neural network business applications, including accounting, finance, production, or economic research.

3.1. Year of publication

Large amount of research has been done in the last two decades. Fig. 1 introduces the distribution of published articles by year in period of 1994–2015. After decline in period between 2001 and 2003, the number of papers sharply increased and peaked in 2012

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