Artificial Neural Networks in Marketing from 1999 to 2003: A Region of Origin and Topic Area Analysis

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Abstract

Artificial Neural Networks (ANNs) are computer programs that model, at an abstract level, the neural connections found in brains. They are powerful general-purpose tools used in many data analysis tasks, such as prediction, classification and clustering. During the period 1999 to 2003, approximately 22,500 journal articles and 13,800 conference papers were published in the field. This paper presents an analysis of 88 publications that reported on the use of ANNs in marketing during that period. To obtain the publications, five bibliographic databases were searched for articles containing the terms "neural networks" and "marketing." A limited number of category analyses are presented, concentrating on: number of papers per year, region of publication (country and continent), and study objectives and topic area. The paper shows that the number of published research papers using ANNs in marketing has increased every year since 1999. The majority of marketing applications of ANNs have been in the more "technical" fields of power supply prediction and information technology. The United States, Europe and Asia have been the main sources of papers in the field. A lack of research and publications from Australia and New Zealand was noted.

Keywords: neural networks, marketing applications, computational intelligence

Introduction

Artificial Neural Networks (ANNs) are powerful general-purpose software tools used for a number of data analysis tasks such as prediction, classification and clustering. They are based on abstract simplified models of neural connections. The concept was first proposed in the 1940s (McCulloch and Pitts, 1943), made limited progress in the 1950s and 1960s (Rosenblatt, 1958), and experienced a resurgence in popularity in the 1980s (Rumelhart and McClelland, 1986). Since then, ANNs have generated considerable interest across a number of disciplines, as evidenced by the number of published research papers in the field. Approximately 22,500 journal articles and 13,800 conference papers were published in the field during the period 1999 to 2003, primarily investigating neural networks in such fields as fluid dynamics, psychology, engineering, medicine, computer science and business.

In 1991 (Hruschka, cited in Krycha and Wagner, 1999), drew attention to the scarcity of articles applying ANN techniques to marketing issues. Since that time many publications have appeared. As might be expected early in its development, many of these studies compared ANNs with other more established techniques such as regression, discriminant analysis, and cluster analysis (Venugopal and Baets, 1994a). Many application areas of ANNs in marketing have been suggested, including market response modeling, retail sales forecasting, direct marketing, and target marketing (Krycha and Wagner, 1999; Mazenec and Moutinho, 1999; Venugopal and Baets, 1994b; Zahavi and Levin, 1995).

The most recent published review of ANN applications in business was by Wong, Lai and Lam (2000), who surveyed articles published between 1994 and 1998. Other business areas that have been reviewed include marketing (Lin and Bruwer, 1996) and management science (Krycha and Wagner, 1999). This paper focus on research publications published during the period 1999 to 2003, concentrating on the use of neural networks in the field of marketing.

To obtain the sample of publications analysed in this paper, five bibliographic databases were searched for articles containing the terms "neural networks" and "marketing" published between 1999 and 2003 inclusive. The databases searched were: Engineering Village 2, EBSOCHost, Science Direct, ISI Web of Science, and Proquest.

Analysis and Results

Because of space limitations, only a limited number of analyses are presented in this paper. A bibliography of the research papers that comprised the data set will be presented in a more extensive publication currently in preparation. This paper concentrates on three specific areas, covering number of papers per year, region of publication (country and continent), and study objectives and topic area.

Number of Papers per Year

A total of 88 papers were published between 1999 and 2003, which is approximately 0.24 percent of the total number of research papers published in the neural network related field during that period. This compares with 24 papers relating to marketing published during the period 1994 to 1998 (Wong, Lai and Lam, 2000). Figure 1 illustrates the trend in the number of papers published between 1994/98 (assuming an average of five a year) and 2003. This shows there has been a continual increase in the number of papers per year except in the year 2003. Most of these research papers were published in journals (79%). Sixteen percent of papers were presented in conferences while four percent were jointly published in journals and at conferences. All of the conferences identified were held in either the USA or Canada.

Figure 1. Trend in Number of ANN Publications for 1994 to 2003.
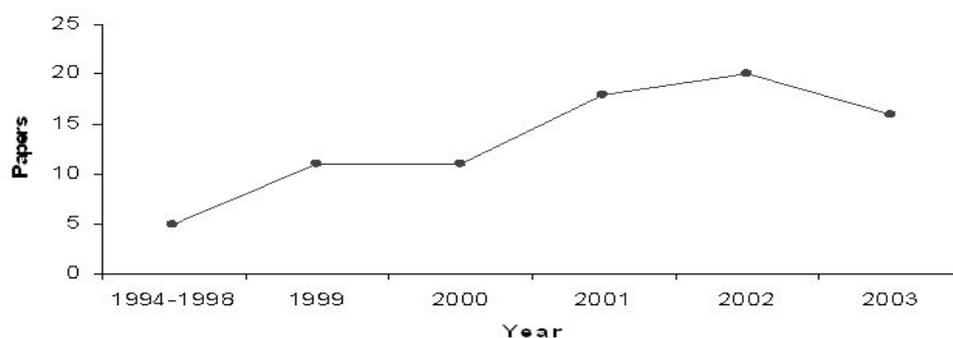

Region

The country with the most number of publications was the USA (19). There were also significant contributions from three other countries: United Kingdom (14), Germany (10) and Taiwan (10). Belgium, Canada, Singapore and Sweden contributed three papers each. Contributions were also made from Australia, Austria, China, Hong Kong, Ireland, Japan,

Kuwait, Netherlands, Poland, Scotland, South Africa and South Korea. Three organisations with significant contributions of three or more papers were National Taipei University of Technology (Taiwan), Chung Yuan University (Taiwan) and University of Boras (Sweden).

To provide an overview of publishing activity, the sample was analysed by continent of origin (see Figure 2). Europe, with 45.7% of the total, was the leader in investigating the role of neural networks in marketing. North America was second with 27.2% of the research papers. There were no papers published from South American. Surprisingly the Oceania region (Australia and New Zealand), despite having a developed academic and funding infrastructure, contributed only 1.2% of the publications, behind Africa with 2.5%. The majority of papers that were published were written in English, except for one in Chinese (published from China).

Figure 2. Continent of Origin for ANN Publications
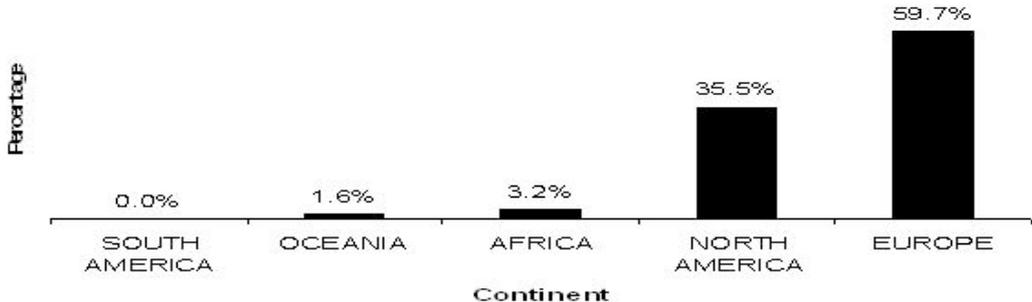

Study Objectives and Topic Area

A number of different objectives for the use of ANNs were identified in this survey, but they can all be conceptualised under the broad heading of forecasting. The top four objectives were sales forecasting, segmentation analysis, price forecasting, and forecasting customer behaviour (Figure 3). Aspects of customer behaviour that were studied included customers' reactions to store locations, and brand choice. Other objectives addressed by ANNs were advertising and promotion, electricity load prediction, customer relationship management, risk analysis, and trends in technology.

Figure 3. Objectives of ANN Research Publications
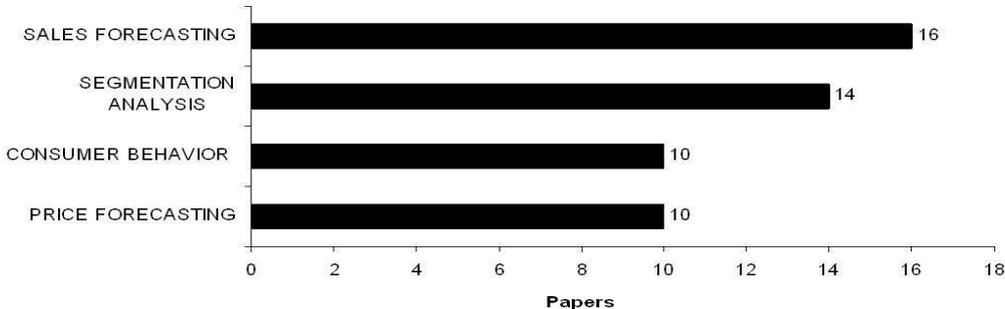
The most published area investigating the use of ANNs was the electricity sector (12 publications), where the technique was used to forecast load and price issues. The general area of information technology applications in marketing had 11 publications and the retail sector had 10 papers. Other areas represented included tourism, food, sports, crude oil, banks, call centres, and telecommunications. Figure 4 shows these results.

Figure 4. Business Sectors with ANN Applications
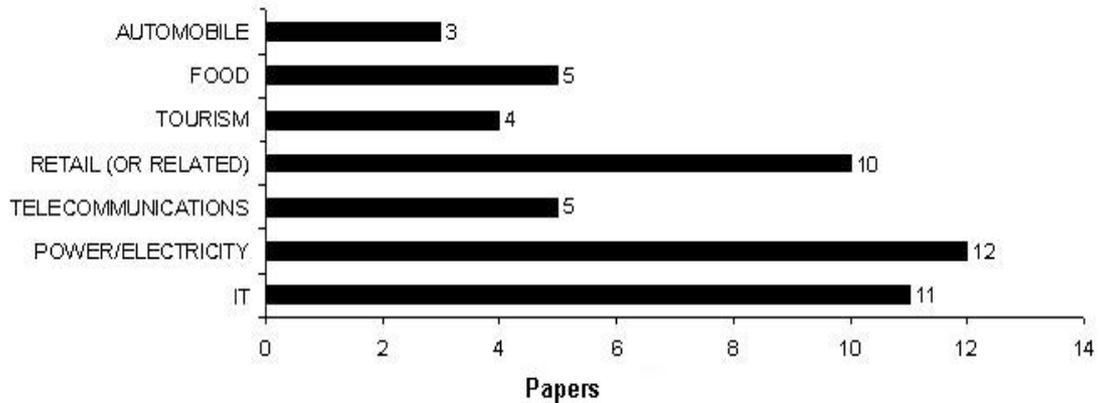
Country of Origin by Year of Publication

A cross tabulation was conducted to more closely analyse trends in the literature. The results are shown in Figure 5, which considers the relationship between country of origin and year of publication. The four countries with the highest number of publications over a six-year period (USA, United Kingdom, Germany, Taiwan) are shown, with the other 16 countries shown in the "other" category. This shows that Germany has consistently published papers over the six-year period. Taiwan has been more inconsistent in its output, probably due to the small number of researchers responsible for producing the output. The USA has grown constantly over the time period, producing the most papers overall in 2003. Countries in the "other" category, after being very prolific in 2001 and 2002, considerably reduced their output in 2003.

Figure 5. Country of Origin by Year of Publication
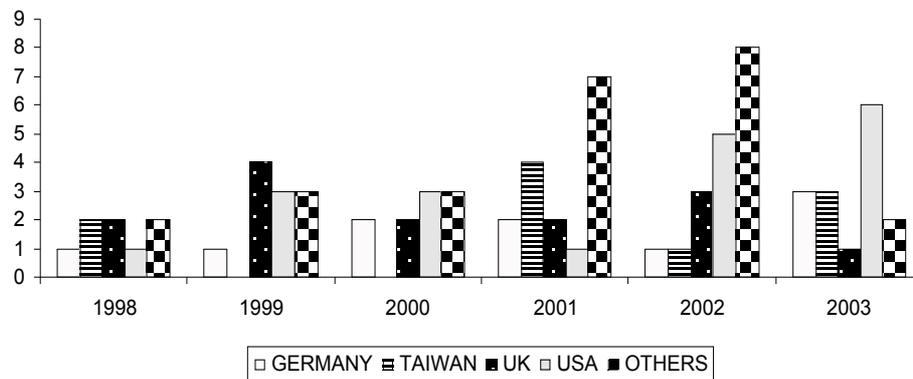
Discussion

Artificial Neural Networks have been applied to numerous marketing problems, for example, new product development (Thieme, Song and Calantone, 2000), sales forecasting (Kuo, 2001), market segmentation (Boone and Roehm, 2002; Hruschka and Natter, 1999), and marketing strategy (Li, 2000). The technique has been applied in a wide range of industries, for example, the food industry (Corney, 2002), retailing (Decker and Monien, 2003), and banking (Moutinho and Phillips, 2002).

Some limitations can be identified with the type of study reported here. Nevertheless, there are a couple of interesting conclusions that can be drawn concerning the use of ANNs in published marketing applications, as well as the contribution of the Oceania region to this important area of research and application.

Limitations

The database for our survey only considered research papers published in journals and conference proceedings, which have been abstracted in the bibliographic databases indicated above. We have not included doctoral dissertations. Some more obscure or new journals may have been excluded. Of course, one of the underlying difficulties with all studies relating to the general use of computational intelligence techniques (including neural networks) in business related applications is the issue of confidentiality, especially with applications that are commercially successful. Reports of such studies are unlikely to make it into the public domain until they are no longer useful, if at all. To overcome these limitations, considerable effort was exerted to maximise the accuracy and coverage of the data set.

Conclusions

Despite these limitations, the findings briefly presented above provide a number of specific conclusions. Firstly, there has been a steady increase in the number of published research papers reporting the use of ANNs in marketing. The number of papers published in the field has been increasing every year since 1998 (except for 2003). This drop may simply be a statistical aberration, although it could also be due to the increased interest in applications of other computational intelligence techniques, such as evolutionary algorithms and rough sets (Voges and Pope, 2004; Voges, Pope and Brown, 2002).

Secondly, many marketing applications of ANNs have been in the more "technical" fields of power generation and information technology, possibly due to the involvement of engineering and IT personnel who are more comfortable with and more aware of the importance of this innovative technology. There is a need for an increase in awareness in other areas of marketing to complement the limited work undertaken in retailing and direct marketing.

Finally, the United States has been the forerunner in investigating the application of ANNs in marketing, and this trend has grown considerably in the last few years. However, there have been a significant number of papers published in European and Asian countries, with the combined European output outperforming the US, and with the number from Asia increasing considerably in the last few years. The lack of research and publications from Australia and New Zealand is of concern. It is recommended that interested practitioners and academics collaborate on undertaking research in this innovative area.

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