Artificial Neural Networks for Business Analytics

William A. Young II
Ohio University, USA

Trevor J. Bihl
Air Force Institute of Technology, USA

Gary R. Weckman
Ohio University, USA

INTRODUCTION

Humans are naturally suited for recognizing and interpreting patterns; however, large and complex datasets, as in Big Data, preclude efficient human analysis. Computational pattern recognition encompasses means of describing, classifying, grouping, categorization, and/or clustering data (Jain, Duin, & Mao, 2000). Expanding on the concept of pattern recognition is knowledge discovery in datasets (KDD), the process of finding non-obvious patterns or trends in datasets primarily to assist in understanding complicated systems (Mannila, 1996). Within a world of decreasing cost of computer storage, increasing capabilities of computer processing performances, and increasing complexity of today's business problems to solve, data analysts are encouraged to adopt more robust data mining methods. One such methodology described in this chapter is an artificial neural network (ANN).

Perspective of Chapter

ANNs provide one approach of solving complex problems in business (Jain, Duin, & Mao, 2000). ANNs are desirable because they provide a well-structured framework to discover non-linear relationships within data sets that are considered 'noisy' or complex. Thus, the primary benefit of utilizing this type of model is the improved accuracies that are obtained when creating models for classification or prediction, which can be used to make better business decisions. For example, business decisions related to up-selling, cross-selling, or demand-planning could all be improved upon if more accurate decision models are created. Though improved accuracies can be obtain, there are many reasons why the field of business has been slow to adopt the modeling practice. For example, ANNs are rooted in machine learning, which may be intimidating for some, especially, since the term is relatively new. ANNs also require much more data to derive than common methods like multiple linear regression. They also take a great deal of time to develop, since a trial-and-error approach is needed to determine the 'best' model. In addition, while ANNs have proven to be accurate classifiers and predictors in business applications, some hesitation and misconceptions appear due to the 'black-box' nature of ANNs (Dewdney, 1997) (de Marchi, Gelpi, & Grynaviski, 2004), hence traditional statistical-based models are far more used in practice.

Objectives of Chapter

The objective of this chapter is to provide readers with a general background of ANNs and their business applications, where the target audience is intended to be readers who may not be familiar with this form of mathematical modeling practice

DOI: 10.4018/978-1-4666-5202-6.ch019

but may want to pursue it for their business needs. The goal of this chapter is to provide readers with a background and common issues related to the development of an ANN. As a starting point, this chapter begins by describing the foundational concepts that relate to ANNs. Moreover, an overview of their biological inspiration, their mathematical representation, and architecture will be discussed in an effort to make the topic less intimidating to readers. Additionally, the authors also provide a brief overview of the primary steps that are needed to derive an ANN model. For instance, data needs to be pre-processed, an ANN architecture needs selected, training methods and heuristics need to be implemented, and the results need analyzed. Finally, the authors have provided readers with a list of business related endeavors as a suggestion for further reading.

Background

ANNs refer to interconnected networks of nodes, which manipulate data from input to output feature-space (Jain, Duin, & Mao, 2000). ANNs are computationally complex and the learning curve to develop an ANN use to be very step; however, various software packages are now available for practitioners, which remove much of the burden placed on truly understanding the mathematical backbone in which ANNs are derived. For example, titles include SPSS (2013), which is perhaps the most well adopted data analysis software package, NeuroDimensions (2013), which has an extremely powerful, yet user-friendly add-in to Microsoft Excel, and other options such as Matlab (2013), and R (2013).

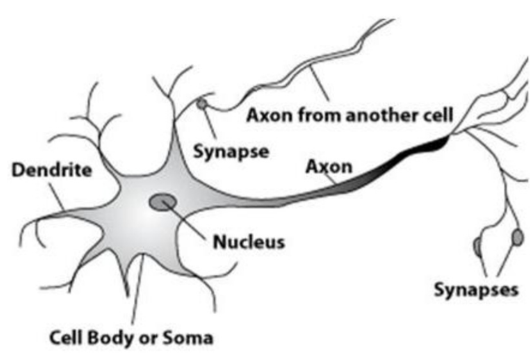
A Biological Inspiration

ANNs are non-linear machine learning models, closely associated with the field of artificial intelligence. ANNs are often called ‘universal approximators’ (Reed & Marks, 1998) due to their mathematical success of modeling a variety of problem domains and types, such as function approximations (Young, Weckman, Thompson, & Brown, 2008), and classifications (Efraim, Jay, Liang, & McCarthy, 2001). ANNs are neurologically inspired models with the intent of representing complex non-linear input and output relationships. The earliest known development of the ANN model was in the 1940s (McCulloch & Pitts, 1943), with the fundamental building block of the ANN model being the neuron. Figure 1 displays a basic sketch of the biological neural network model (Neuralpower, 2007). In general, the neuron receives weighted input singles from synapses through the many axons. The neuron then processes the signal and passes the signal through dendrites, which lead to other cell bodies, which represents the interconnected framework of the human brain.

A Mathematical Representation

A single ANN neuron, a *perceptron*, with one input and one output node is akin to logistic regression (Timmerman, et al., 1999). In operation, ANNs are represented by multiple interconnected neurons, inputs, and outputs. ANNs incorporate organizational and iterative principles for learning nonlinear input-output relationships through training and testing means (Jain, Duin, & Mao, 2000). ANNs generally consist of three types of layers: input, hidden, and output. Great flexibility exists in constructing an ANN, multiple hidden

Figure 1. Biological neuron (Young, Holland, & Weckman, 2008)



Related Content