Chapter 12
Neural-Symbolic Processing in Business Applications:
Credit Card Fraud Detection

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1. ABSTRACT

Neural networks are mathematical models, inspired by biological processes in the human brain and are able to give computers more "human-like" abilities. Perhaps by examining the way in which the biological brain operates, at both the large-scale and the lower level anatomical level, approaches can be devised that can embody some of these remarkable abilities for use in real-world business applications. One criticism of the neural network approach by business is that they are "black boxes"; they cannot be easily understood. To open this black box an outline of neural-symbolic rule extraction is described and its application to fraud-detection is given. Current practice is to build a Fraud Management System (FMS) based on rules created by fraud experts which is an expensive and time-consuming task and fails to address the problem where the data and relationships change over time. By using a neural network to learn to detect fraud and then extracting its' knowledge, a new approach is presented.

2. INTRODUCTION

Given the high stakes and intense competition in almost all industries, making intelligent business decisions is more important than ever - few disagree that information is a powerful business asset. The ability to harness that power to drive the decision-making processes that are central to a business's success is fundamental. Over the last three decades, businesses have been faced with growing quantities of transaction data, in terms of the number of records and fields; typically, millions of records and hundreds of fields. Their unenviable task is to extract suitable information from this raw data. As well as summaries of current or past performance, they need to study the complex inter-relationships between various factors. Given a thorough understanding, predictions can be made and decisions determined. When faced with this task, the traditional ap-

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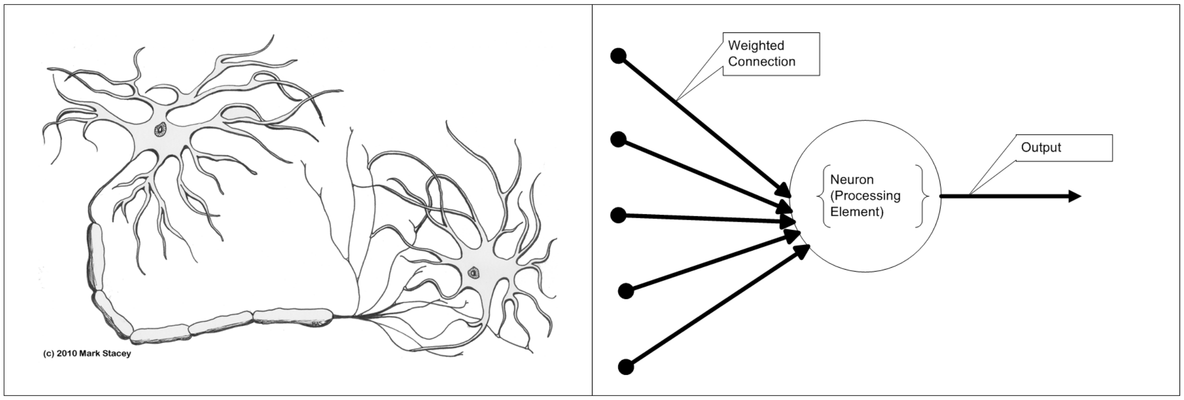
Figure 1. Left: biological neurons. Right: artificial neuron



proach has been to use analytical or AI methods. These methods produce a hypothesis based on *a priori* knowledge – typically in the form of rules (a knowledge-base) or a model induced from labeled examples (for which a classification is already known). However, there are many areas where such an analytical approach fails to provide the information needed. Business, like nature, is often chaotic and an approach is needed to tame this chaos, to be able to provide information even when the task is subjective, when it is not possible to have an example of every pattern in order to make a decision. Giving computers more "human-like" abilities, for example allowing them to make judgments, requires a different approach. Humans learn by example and do not need to see every example to make a guess, a judgment based upon what has been taught.

Neural networks are mathematical models, inspired by biological processes in the human brain. They are constructed from a number of simple processing elements (neurons) interconnected by weighted pathways to form networks. Each element computes its output as a non-linear function of its weighted inputs. Figure 1 compares a biological neuron with an artificial neuron. When combined into networks, these processing elements can implement complex non-linear functions that are used to solve classification, prediction or optimization problems. Knowledge is encoded and distributed throughout the neural network architecture using an iterative learning algorithm. The neural network is therefore polythetic – all inputs are simultaneously considered to produce an output. Unlike conventional systems, neural networks are not programmed to perform a particular task using rules. Instead, they are trained on historical data, using a learning algorithm. The learning algorithm changes the functionality of the network to suit the problem by modifying the values of the connection weights between processing elements. Once trained, the network interprets new data in a way that is consistent with the experience gathered during training.

Neural networks can provide highly accurate and robust solutions for complex non-linear tasks such as fraud detection (N. Ryman-Tubb, 1998), business lapse/churn analysis, credit and risk analysis and data mining. One of their main benefits is that the method for performing a task need not be known in advance; instead, it is automatically inferred from the data. Once learned, the method can be quickly and easily adjusted to track changes in the business environment. A further advantage of neural networks over conventional rule-based systems and fuzzy systems is that, once trained, they are far more efficient in their storage requirements and operation. A single mathematical function can replace a large number of rules. An added benefit of this more compact mathe-

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