Advanced Methodologies Descriptions and Applications

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INTRODUCTION

For those knowledgeable in both mathematics and statistics, knowing when to apply Artificial Intelligence (AI) methods and how to use them can help in business applications. Real-world data are not always Gauss Normal distributed. AI methodologies are effective in many applications as they do not depend upon known statistical distributions. They also work with discontinuous functions and are not susceptible to multicolinearity.

A feed forward Artificial Neural Network (ANN) can perform regression, canonical correlation, and pattern recognition, while not constrained to a known distribution. They are able to infer complex non-linear relationships between an input pattern/tuple and output (Azema-Barac, 1997). ANNs have been shown to reduce residual on time series forecasting on financial data sets including foreign exchange (Morantz, 2008). They can also perform both linear and non-linear regression; and, as such, are capable of pattern recognition and forecasting.

One of the limiting factors in application of neural networks to commercial products is that the rationale can not be explained, as only the inputs and the prediction are available. It is called a 'black box model' as one can not look inside and see what is happening. The rationale for why an ANN recommended declining credit to someone is not available with this methodology. Legal regulations in many places require the explanation for the denial of credit. Other processes like rule induction and data mining are required to generate an explanation for a forecast from a neural network. Research in this area continues.

Biological entities are far superior at pattern recognition than our machines, especially when pattern generalizability (ability to recognize something when there are changes including the environment) is considered (Mehrotra et al., 1997). Business applications utilizing this method include credit vetting, fraud detection, and risk analysis. These functions are critical to successful and profitable financial enterprises. AI techniques, when used properly, are capable of recognizing various patterns and scenarios, hence improving bottom line performance.

Exploited search algorithms, like Genetic Algorithms (GA), can solve some very difficult and time consuming problems. The Traveling Salesman Problem (TSP) is a well known example. This problem has discrete variables, constraints, and discontinuities. There are no mathematical solutions and an exhaustive search would take weeks or longer on a computer. The application to business is obvious, as the more customers that a salesman can effectively visit per period of time, the higher the revenue and hopefully the profit that will be earned.

Another advantage is that these systems work well in hyperspace (or N-space) which applies to complex problems with many variables. Multivariate regression is typically performed by canonical correlation, or what is also referred to as the general linear model. Many constraints are placed on this process. As an ANN does not build a model but rather learns input to output relationships, it can work effectively with multiple output variables, without all of the constraints. Many other problems in the mathematical world are solved using advanced methodologies.

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This chapter will discuss the most common AI applications for business analytics, what they are, and how they can be used to improve the quality and accuracy. Example problems will help to illustrate the application and some of the concerns that have been raised, many of which have been overcome.

BACKGROUND

Artificial intelligence has been around since the mid-twentieth century. Theory of its existence goes back much further, but it did not become a popular subject until the advent of digital computers. Its popularity varied over time and research in the field oscillated. As increasingly powerful computers became available, the subject had a renaissance. Many problems which were once called impossible or in the realm of AI, are now common and people take them for granted (Bostrum, 2006). Among these are such things as Optical Character Recognition (OCR), spell and grammar checkers, and speech recognition programs.

Some statisticians realized that these systems can be utilized mathematically to solve complex problems with known or unknown distributions. The Society for AI and Statistics was organized for this purpose and has annual meetings to present research papers in this new and expanding field. While many of the statistical packages assume a Gauss Normal distribution, such assumptions do not exist in these AI programs.

Many of the systems need to "learn," just as a human being needs to learn, with a process called supervised training. The supervision is the inclusion of the answer to the problem with the training data sets, much like class room studies for humans, where one learns about various subjects. There are some special processes, called unsupervised learning, where no answers are included with the data set, but these are not as common in business applications.

Typical system verification is an 80/20 process. Eighty percent of the data is used for training the system. The remaining 20 percent is input to the system and the predicted answer is compared to the answer from the data set. This will allow one to determine the accuracy of the system. If the data is time ordered, some of the newer methods weight the newer data heavier because it is more recent and closer to current performance (Morantz et al., 2008).

A method that sounds strange is using a genetic algorithm to search for failure points. One normally thinks of using these for finding the best solution to a problem or optimization of a system. The Office of Naval Research has used these exploited search routines to find unstable points in large systems (Schultz et al., 1995). Some systems are so vast that an exhaustive test (testing of all possible inputs) would require an unreasonable amount of time. Systems like this are typically volume tested by systemic organization such as Taguchi or Latin Hypercube. Schultz has shown that a genetic algorithm that has a fitness function rewarding for bad performance has successfully been able to find additional unstable points in variable space that eluded the volume filling methods.

NEURAL NETWORKS

Artificial neural networks are highly interconnected function approximators (Masters, 1993). They fall into the broad category of artificial intelligence because their design is based upon a brain in the biological world. Animal brains are made up of neurons (cells) that are multiply interconnected. Most common theory has knowledge stored in the weights of the connections. When the inputs exceed a certain threshold level, the neuron generates an output pulse, called "firing". This general design is programmed into algorithms called artificial neural networks.

Well known for their ability to learn and generalize (Sarle, 1994), ANNs do not form a causal model but rather learn input to output relationships. Because of this, they are capable of handling unknown distributions and multicollinearity (Sprecht). They can be used for time

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