A Study of Digit Recognition and Decision Making Tool for Managers

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Abstract

Approaches to decision making can be quite diverse, ranging from classical, rationalistic, decision making processes to a less structured, intuitive, decision making style. Rational decision making processes consist of a sequence of steps designed to rationally develop a desired solution. Intuitive decision making is almost the opposite, being more instinctive, subjective and subconscious in nature. One of the principle assumptions of the rational decision making process is that human beings make rational decisions. However, this is not always the case! There are usually wide ranging factors which determine our decisions, many of which are not rational. This is especially so when we remember that management is about dealing with people. In addition, many situations require decisions to be made with incomplete and/or insufficient information. Often management requires quick decision making, or judgements made under pressure. It is in this context that a more intuitive approach often develops. All except the most mechanistic of rational decisions must include some element of subjective judgements. Our decisions are based on judgements which are affected by a range of factors including our experiences, values, attitudes, and emotions. Judgements heuristic decision making uses simple rules and approximate short cuts to help us arrive at decisions. Drawing particularly on our experiences and attitudes, it does this by helping us to cut through the excessive information that can overload and delay decisions.

Keywords: *Digit Recognition, Decision Making Tool, Decision Making Style, Management Requires.*

1. INTRODUCTION

Neural networks have been used successfully in operations management, particularly in the areas of scheduling and planning. R&D regarding the scheduling of machinery, assembly lines, and cellular manufacturing using neural networks has been increasingly prevalent over fifteen years. Other scheduling problems, like timetabling, project scheduling, and multiprocessor task scheduling have also been addressed with neural networks. The use of neural networks in various operations planning and control activities cover a broad spectrum of application, from demand forecasting, to shop floor scheduling and control. Neural networks have also been used in conjunction with simulation modeling to learn better manufacturing system design. Operations management also benefit from neural networks in the area of quality control, as neural networks can be integrated with traditional statistical control techniques to enhance their performance. Examples of this include a neural network used to monitor soda bottles to make sure each bottle is filled and capped properly. Neural networks can also be used in diagnostics, and have been used to detect faults in electrical equipment and satellite communication networks. Project management tasks have also been tackled by using neural networks to forecast project completion times for knowledge work projects, or to predict workloads and delivery times in software engineering and development projects.

As seen already, neural computers have the ability to learn from experience, to improve their performance and to adapt their behavior to new and changing environment. Unlike conventional rule-based 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, business lapse/churn analysis, 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 mathematical representation is that it introduces a natural form of regularization or generalization. This makes neural systems extremely robust to noisy, imprecise or incomplete data.

The time needed to develop a neural application is often less than that in a conventional approach, since the interaction between the analyst and the expert is minimised-there are no algorithms or rules to define. The scope and accuracy of the finished application is improved since the neural computer can be exposed to many more examples than can be assimilated by a single human.

Early criticisms relating to the lack of explanatory information on how a neural network performs its task have now been largely overcome. Techniques such as sensitivity analysis can be used to identify which input variables have the largest effect on a particular decision or prediction. Furthermore, neural networks can now be structured to incorporate prior expert knowledge and present results in a form that is meaningful to human users.

2. SYSTEM APPROACH OF NEURAL NETWORKS

Neural Networks have connections with a lot a fields, including: Biology, Neurophysiology, Cognitive Psychology, Informatics (Artificial Intelligence, Data Mining), and Engineering (Signal Processing, Adaptive Control), Mathematics (Linear Algebra, Numerical Analysis, Statistics, Differential Equations), Economy (Stock Prediction, Risk Analysis).

As in any other field, the study of neural networks has also experienced periods of intense research, and periods when the estate was neglected. Studies began its state in the late nineteenth century, early twentieth century, and those who issued the first theories in this area are Hermann von Helmholtz, Ernst Mach and Ivan Pavlov.

The first practical application, the perceptron, appeared in 1959 - carried out by Frank Rosenblatt used for character recognition. Amongst the areas where the use of neural networks had good results are:

- Approximations of functions;
- Control of industrial robots;
- Classification;
- Recognition of patterns and voices;
- Financial projections;
- Market Research;
- Forecast of marketing;
- Medicine etc.

In recent decades, advances in neuroscience have been spectacular, particularly those related to the properties of neurons and complex molecules that affect neuronal response.

Thus, the discovery of brain nature and principles which govern the activity, we may be able to understand the functions of perception, learning and other mental functions. Knowledge of the human brain functions, central nervous system, allowing us to understand how the artificial neuronal networks (neural networks) work and are developed. In 2013, scientists from the University of Illinois, Chicago (UIC) have tested one of thebest artificial intelligence systems - Concept Net and the results showed that the system is as intelligent as a normal child with the age of four years, except the fact that the scores varied from one subject to another.

The Turing Test consists in a simple conversation between a human being and a machine (computer) software specifically for the test. Those who participated at the conversation were not able to see or hear each other. If the jury, after the conversation, could not distinguish the man and the computer, then the computer (the artificial intelligence) won. Turing started from a very simple idea: if we cannot define intelligence, but still say about a person that is smart, then why can’t we say the same thing about a machine (robot) that would act like a human.

Artificial Neural Networks: Applications in Management

Classification is one of the most frequently encountered decision making tasks of human activity. A classification problem occurs when an object needs to be assigned into a predefined group or class based on a number of observed attributes related to that object. Many problems in business, science, industry, and medicine can be treated as classification problems. Examples include bankruptcy prediction, credit scoring, medical diagnosis, quality control, handwritten character recognition, and speech recognition. Neural networks have emerged as an important tool for classification. Neural networks have seen an explosion of interest over a last few years and are being successfully applied across an extraordinary range of problem domains. The excitement stems from the fact that these networks are attempts to mimic the capabilities of the human brain.

Artificial neural networks are distributed information processing systems composed of many simple computational elements interacting across weighted connections. ANNs can identify and learn correlated patterns between input data sets and corresponding target values. After training, ANNs can be used to predict the outcome of new independent input data. ANNs seek to simulate the human brain structure, human thinking and human learning in a machine. Thus they are ideally suited for the modeling of agricultural data which are often complex and non-linear.

These networks are “neural” in the sense that they have been inspired by neuroscience but not necessarily because they are faithful models of biological cognitive phenomena. The majority of the networks are closely related to traditional mathematical and statistical models such as clustering algorithms, non-linear filters etc.

An ANN consists of many single processors, which interact through a dense web of interconnections. A neuron or processing element has primarily two things to do. One is that it computes output which is sent to another neuron which determines its output value by applying a transfer function. Two, it updates the local memory, i.e. weights and other data types called data variables. These processing elements are organized into two layers. The first layer is known as the input layer and the last layer is referred to as the output layer. The one or more inner layers are known as hidden layers. The input neurons receive values from outside the neural networks’ environment, whereas the output neurons send the values to this outside environment.

Characteristics of Neural Networks

- The NNs exhibit mapping capabilities hence they can map their input patterns to the associated output patterns.
- Since the NNs learn by examples, the NN architecture can be trained with known examples of a problem before they are tested for their inference capability on unknown instances of the problem.
- They possess the capability to generalize.
- They are robust systems and fault tolerant and hence they can recall full patterns from incomplete, partial or noisy patterns.
- They can process information in parallel at high speed and in a distributed manner.
- They can be used to cluster the training data into natural groups based on the similarity of characteristics in the training data.

Neural Networks: Basics

The terminology of artificial neural networks has developed from a biological model of the brain. A neural network consists of a set of connected cells: The neurons. The neurons receive impulses from either input cells or other neurons and perform some kind of transformation of the input and transmit the outcome to other neurons or to output cells. The neural networks are built from layers of neurons connected so that one layer receives input from the preceding layer of neurons and passes the output on to the subsequent layer.

Neural networks architectures

An ANN is defined as a data processing system consisting of a large number of simple highly inter connected processing elements (artificial neurons) in an architecture inspired by the structure of the cerebral cortex of the brain. There are several types of architecture of NNs. However, the two most widely used NNs are discussed below:

- **Feed forward networks**

In a feed forward network, information flows in one direction along connecting pathways, from the input layer via the hidden layers to the final output layer. There is no feedback (Loops) i.e., the output of any layer does not affect that same or preceding layer.

- **Recurrent networks**

These networks differ from feed forward network architectures in the sense that there is at least one feedback loop. Thus, in these networks, for example, there could exist one layer with feedback connections as shown in figure below. There could also be neurons with self- feedback links, i.e. the output of a neuron is fed back into itself as input.

- **Learning/Training methods**

Learning methods in neural networks can be broadly classified into three basic types: supervised, unsupervised and reinforced.

- **Supervised learning**

In this, every input pattern that is used to train the network is associated with an output pattern, which is the target or the desired pattern. A teacher is assumed to be present during the learning process, when a comparison is made between the network's computed output and the correct expected output, to determine the error. The error can then be used to change network parameters, which result in an improvement in performance.

- **Unsupervised learning**

In this learning method, the target output is not presented to the network. It is as if there is no teacher to present the desired patterns and hence, the system learns of its own by discovering and adapting to structural features in the input patterns.

- **Reinforced learning**

In this method, a teacher though available, does not present the expected answer but only indicates if the computed output is correct or incorrect. The information provided helps the network in its learning process.

A reward is given for a correct answer computed and a penalty for a wrong answer. But, reinforced learning is not one of the popular forms of learning.

A neural network model for decision making

This paper deals with the design and development of a neural network based decision making model. The model helps management personnel in the construction industry decide whether to use a conventional construction method or to use certain degree of modular construction method when planning to build an industrial process plant either within or outside the United States. The feasibility of construction modularization depends on the specific project situation, organizations involved, social, legal and environmental conditions. In some obvious project environments, such as remote sites, harsh weather conditions, etc., modularization represents the only feasible choice. On the other hand, in some other situations the decision to modularize is not as obvious. Therefore, at the initial stage of a project, management must decide whether to investigate the modularization potential.

In the past, there has never been an easy-to-use method that can be used to determine modularization feasibility. The only way in which companies have utilized modularization in the past has been when an expert in the field was consulted from within the organization or from another organization. However, there are many engineering and construction and owner companies which need to be able to determine modularization feasibility of a project in a simpler and more easily accessible way. An expert system has already been designed to achieve this goal. However, the results of the research presented here show that a neural network approach outperforms an expert system for the present problem.

Additionally, the neural network based system can handle the inexact and incomplete inputs in order to reach a conclusion and, thus, is more appropriate for unstructured decision making environments like construction modularization.

3. EXPERT SYSTEM APPROACH

Modular construction is a method for constructing units of a project in a remote location from the final project site. Modularization brings the advantage of the manufacturing process to the construction industry, such as a controlled environment (temperature and lighting), improved quality control, improved safety, etc. Modularization offers an opportunity to improve a variety of performance parameters relating to the project, such as cost and schedule. A module is a remotely assembled unit. It is usually the largest transportable unit or component of a facility. It has all structural elements, finishes, and process components fitted. Modules may contain pre-fabricated components or preassemblies.

An expert system for construction modularization decision making has already been developed. During the knowledge base development phase, several hours of knowledge acquisition sessions were held with the experts at the major engineering and construction, fabrication and owner firms in the construction industry. These sessions with modularization experts provided an extensive amount of information about the modularization feasibility study process. The most important discovery was the determination of factors to consider when such a study is performed. These factors can be categorized in the following five groups: Plant Location, Labor Considerations, Environmental and Organizational Factors, Plant Characteristics, and Project Risks.

The analysis of project location includes such factors as accessibility, climatic conditions, bulk commodity quality and availability, construction equipment quality and availability, transportation mode, transport equipment availability and timing. Labor skills, productivity and type (union or non-union) are some of the factors included in the labor related category. Some of the factors related to the project characteristics are repeatability, proprietary security, project type (evolutionary or non-evolutionary), system density, and existing facility impact. Project risks factors category includes schedule, height of construction, quality requirements, etc. Environmental factors include module import restrictions, offsite access concerns, environmental restrictions and social issues. There are some other factors to be evaluated and are included in the organizational factors category. These factors relate to engineering and construction firms (climate towards modularization, willingness to early involvement with osier, etc.), fabricators (availability and capability) and owners (receptivity to modularization, understanding of modularization, willingness to live with the design constraints of modular construction, etc.).

In addition to the five influencing factor categories described above, economics also was determined to be an important factor. Some costs increase with modularization, such as transportation, steel, and engineering; however, total labor costs are reduced due to higher productivity- The potential reduction in schedule, when converted to dollar figures, can become a considerable advantage in the selection of modular construction over traditional methods. In fact, schedule savings are often the driving force for modularization as capital costs for both “stick built” and modular projects can be comparable.

4. OFFLINE HANDWRITTEN DIGIT RECOGNITION USING NEURAL NETWORK

Handwritten character recognition is a field of image processing as well as pattern recognition. There are two approaches for the pattern recognition such as statistical and structural. In statistical approach, the set of characteristic measurements of the input data is generated on the statistical basis and is assigned to one of the n classes.

The structural description of the object is based on the interconnections and interrelationships of features of input data. In general, both approaches are widely used in the pattern recognition. Since the handwriting of different writers is different, building a general recognition system that would recognize all characters with good reliability is not possible in every application. Thus recognition systems are developed to achieve reliable performances to the specific applications. In particular, the handwritten digit recognition has been applied to recognize amounts written on checks for banks and zip codes on envelops for postal services. Handwritten digit recognition system can be divided into four stages:

- Data acquisition
- Pre-processing
- Feature extraction
- Classification

5. PRE-PROCESSING STEPS

In offline character recognition system, image which is recognized is captured by the optical scanner. The efficiency of the input data analysis can be improved by pre-processing the scanned images of the characters. Pre-processing phase aims to extract relevant textual parts of the character images by performing various operations such as linearization, noise reduction, thinning, skeletonization, normalization and compression.

Image is distorted due to the noise introduced by image acquisition such as optical scanning and binarization. It is impossible to remove such distortion but can be decreased by various noise reduction techniques. These techniques can be categorized into three major groups such as filtering using convolution operations, morphological operations using logical operations and noise modeling. When image is captured, it is in the grey scale format i.e. in the form of pixel density value between 0 to 255. In binarization, the grey scale image is threshold and converted into binariesimage in the form of 0 and 1. There are two methods to binaries the image such as global thresholding and local thresholding. In global thresholding only one threshold value is chosen for entire document. Local thresholding uses different threshold values for each pixel with the help of local area information.

6. FEATURE EXTRACTION

Since many classifiers cannot process the raw images or data efficiently, extracting the relevant information of the data is needed. Feature extraction is the step that aims to extract relevant information by reducing the dimension of the data. The performance of the classifiers depends on quality of the feature extracted from the data. In character recognition system, the commonly used features are statistical, structural, moments and global transformations.

For extracting the features and executing the classification steps, the frame of digit is required after narrowing them. This frame includes the important data of input digits and the unnecessary data of an image is removed. For finding the narrowed frame of digits, the coordinates of pixels of foreground in farthest left, right, up and down side are found. In such conventional feature extraction technique, if a line passes through a pixel (foreground), then the corresponding pixel will be given value one (1). If line does not pass a pixel (background), then it is taken as zero (0).

Artificial Neural Networks in Decision Support Systems

The increasing complexity and uncertainty associated with today's decision situations necessitate the managers to use sophisticated quantitative models that go beyond the capabilities of traditional simple linear models. As the complexity and uncertainty with the data (that describes the decision situation) increase, the capabilities of the model (that represents the situation) should also increase, so that highly nonlinear relationships among the variables can also be captured. This is where the artificial neural networks (ANN) fit into the realm of managerial decision support. Specifically, ANN can be considered to play the role of the "quantitative models" in model-driven decision support systems, according to Power's classification of decision support systems. Power came up with five categories based on the dominant component of the decision support system: communication/group-driven, data/document-driven, knowledge-driven, model-driven, and Web-based/inter-organizational decision support systems (DSS). Model-driven DSS refers to the type of DSS where an underlying model of a specific situation is built that is then used to analyze different alternatives and aid in decision making.

Traditionally, these models can be of many different types: optimization, simulation, decision analysis, etc. Neural networks would represent another type of modeling approach. Neural networks could also be considered to relate to data-driven DSS. In that case, neural networks provide a method for forecasting/analyzing the past data.

Though commonly known as black box approach or heuristic method, in the last decade artificial neural networks have been studied by statisticians in order to understand their prediction power from a statistical perspective. These studies indicate that there are a large number of theoretical commonalities between the traditional statistical methods, such as discriminant analysis, logistic regression, and multiple linear regression, and their counterparts in artificial neural networks, such as multilayered perceptron, recurrent networks, and associative memory networks.

7. CONCLUSION

As managers trained or educated to be rational thinkers, we may be wary of combining intuition and decision making. However, academic research into decision making theory indicates there is a sound logic in reconciling the two. This is particularly important when we remember that decision making is rarely a precise, safe, fully informed process. Though not useful in every situation, where ever there is any ambiguity or doubt in our decision making, then there may be a place for intuitive thinking.

An interesting area of development relating to intuition and decision making, is the work on sense making from organizational theorist Karl Weick. Weick's work relates to our discussion of rational and intuitive perspectives, particularly the inclination of managers to think rationally about decisions. This despite the fact that these decisions are based as much on what they don't know as on what they know! In such circumstances there is much to be said for decision making informed by intuition or heuristics. Weick suggests:

"When people create maps of an unknowable, unpredictable world, they face strong temptations towards either over confident knowing or overly cautious doubt. Wisdom consists of an attitude towards one's beliefs, values, knowledge, and information that resists these temptations through an on-going balance between knowing and doubt".

"The essence of wisdom is in knowing that one does not know, in the appreciation that knowledge is fallible, in the balance between knowing and doubting."

Perhaps this is only highlighting what great managers know already. As Bob Sutton suggests:

"the best leaders have the courage to act on what they know right now, and the humility to change their actions when they encounter new evidence. They advocate an 'attitude of wisdom'. Arguing as if they are right, and listening as if they are wrong.

Determining which type of decision making approach to adopt is essential for effective decision making. However, perhaps knowing how and when to combine rational and intuitive approaches is essential for effective management.

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