APPLICATION OF ARTIFICIAL NEURAL NETWORKS IN THE FIELD OF BIODIESEL

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Abstract

Neural networks, with their remarkable ability to solve complicated and complex data otherwise it is too difficult to solve either humans or other computer techniques. Neural networks take a different approach to problem solving than that of conventional computers. Conventional computers use an algorithmic approach i.e. the computer follows a set of instructions in order to solve a problem. Unless the specific steps that the computer needs to follow are known the
computer cannot solve the problem. This paper discusses about the introduction to Artificial Neural Networks and also brief introduction to models of networks, for then describing in general terms ANNs. This paper also involves about the applications of neural networks in the field of Bio diesel. 

**Key Words:** Artificial Neural networks, Applications, bio diesel, advantages, limitations

1 Introduction

Neural network simulations appear to be a recent development. However, this field was established before the advent of computers, in the year 1943. Neural networks process information in a similar way the human brain does. The network is composed of a large number of highly interconnected processing elements (neurons) working in parallel to solve a specific problem. Neural networks learn by example. They cannot be programmed to perform a specific task. The examples must be selected carefully otherwise useful time is wasted or even worse the network might be functioning incorrectly. The disadvantage is that because the network finds out how to solve the problem by itself, its operation can be unpredictable.

1.1 Networks

One efficient way of solving complex problems is following the lemma divide and Conquer. A complex system may be decomposed into simpler elements, in order to be able to understand it. Also simple elements may be gathered to produce a complex system. Networks are one approach for achieving this.

There are a large number of different types of networks, but they all are characterized by the following components:

1.1.1 Nodes

The nodes can be seen as computational units. They receive inputs, and process them to obtain an output. This processing might be
very simple (such as summing the inputs), or quite complex (a node might contain another network...)

1.1.2 Connections between nodes

The connections determine the information flow between nodes. They can be Unidirectional, when the information flows only in one sense, and bidirectional, when the information flows in either sense.

1.2 Artificial Neural Network Overview

An artificial neural network is a collection of connected models neurons. Taken one at a time each neuron is rather simple. As a collection however, a group of neurons is capable of producing complex results. In the following sections I will briefly summarize a mathematical model of a neuron, neuron layer, and neural network before discussing the types of behaviour achievable from a neural network. Finally, I will conclude with a short description of the program included in this lesson so you can form networks that are tailored to your class.

1.2.1 models

The models presented in this section appear fairly difficult mathematically. However, they eventually boil down to just multiplication and addition. The use of matrices and vectors simplifies the notation but is not absolutely required for this application.

1.2.2 Neuron Model

A model of a neuron has three basic parts: input weights, a summer, and an output function. The input weights scale values used as inputs to the neuron, the summer adds all the scaled values together, and the output function produces the final output of the neuron. Often, one additional input, known as the bias is added to the system. If a bias is used, it can be represented by a weight with a constant input of one. This description is laid out visually below.
Where $I_1$, $I_2$, and $I_3$ are the inputs, $W_1$, $W_2$, and $W_3$ are the weights, $B$ is the bias, $x$ is an intermediate output, and $a$ is final output. The equation for $a$ is given by $a = f(W_1I_1 + W_2I_2 + W_3I_3 + B)$ where $f$ could be any function. Most often, $f$ is the sign of the argument (i.e. 1 if the argument is positive and -1 if the argument is negative), linear (i.e. the output is simply the input times some constant factor), or some complex curve used in function matching (not needed here). For this model we will use the first case where $f$ is the sign of the argument for two reasons: it closely matches the all or nothing property seen in biological neurons and it is fairly easy to implement.

2 ANN IN THE FIELD OF BIO DIESEL

Bio diesels refer to a family of CI engine fuels that are produced from natural sources such as oils of sunflower palm, poongani and jatropha. It is believed that Biodiesels which may be the oils themselves or their esters are the most likely successors to petroleum derived diesel. It is also more practical that these alternate fuels are introduced gradually as blends with diesel so that the production facilities are able to grow and markets are able to switch from petroleum derived diesel to Bio diesels. Studies have shown that often best results are achieved in blending a Biodiesel with diesel in suitable proportions and the results obtained are better than those of diesel or the pure Biodiesel. Hence it becomes extremely necessary to evaluate these blends of Biodiesels with diesel for their performance and emission characteristics. So far most of the research has been concentrated on the testing of the Biodiesel or some particular ratio of blend. Some studies reveal that the characteristics
of these blends do not vary in a linear fashion and there may be certain combinations that might be more advantageous than others from the performance and emissions point of view. Artificial neural networks have been employed as they can produce accurate correlations for non-linear data. Artificial neural networks (ANNs) are recently developed techniques which are invariably used in obtaining accurate correlations which involves non-linear data. An ANN can be considered to be consisting of interconnected group of relatively simple processing elements or nodes, called neurons, where the global behavior is determined by the connections between the processing nodes and the network parameters. Neural networks, when trained properly are good at providing very fast, extremely close approximations of the correct output for non-linear data. Their applications can be categorized into classification, pattern recognition and identification, assessment, monitoring and control, and forecasting and prediction. Modern neural networks can be trained to solve problems that seem impossible for conventional computers or human beings. The objective of this study is to establish correlations in the form of networks between the percentage of Biodiesel in the blend along with the Biodiesels properties and the performance and emission characteristics of a CI engine and to obtain the optimal blend of Biodiesels with diesel which would result in reduced values of SFC, NOX and HC. Due to the nonlinear nature of the problem and the number of variables associated mathematical modeling and/or statistical analysis becomes complicated. However the required objective might be achieved by implementing ANNs, which have already proved to play an important role in the modeling and prediction of the performance and control of combustion processes and in the prediction of exhaust emissions as a function of fuel properties.
3 NETWORK ARCHITECTURE

Fig. 2. Illustration of a feed-forward back propagation neural network model showing input hidden and output layers along with weights and biases.

4 ADVANTAGES OF ARTIFICIAL NEURAL NETWORKS

- Machine-vision MLP
- Neural Network-Based Face Detection
- Automated Car Steering
- Weather forecasting
- To extract emission properties

5 DISADVANTAGES OF ARTIFICIAL NEURAL NETWORKS

The disadvantage is that because the network finds out how to solve the problem by itself, its operation can be unpredictable.

5.1 What Are Their Limitations

There are many advantages and limitations to neural network analysis and to discuss this subject properly we would have to look at each individual type of network, which isn’t necessary for this general discussion. In reference to backpropagational networks how-
ever, there are some specific issues potential users should be aware of.

Backpropagational neural networks (and many other types of networks) are in a sense the ultimate 'black boxes'. Apart from defining the general architecture of a network and perhaps initially seeding it with a random numbers, the user has no other role than to feed it input and watch it train and await the output. In fact, it has been said that with back propagation, "you almost don’t know what you’re doing". Some software freely available software packages (NevProp, bp, Mactivation) do allow the user to sample the networks 'progress' at regular time intervals, but the learning itself progresses on its own. The final product of this activity is a trained network that provides no equations or coefficients defining a relationship (as in regression) beyond it’s own internal mathematics. The network 'IS' the final equation of the relationship.

Backpropagational networks also tend to be slower to train than other types of networks and sometimes require thousands of epochs. If run on a truly parallel computer system this issue is not really a problem, but if the BPNN is being simulated on a standard serial machine (i.e. a single SPARC, Mac or PC) training can take some time. This is because the machines CPU must compute the function of each node and connection separately, which can be problematic in very large networks with a large amount of data. However, the speed of most current machines is such that this is typically not much of an issue.

5.2 What Are Their Advantages over Conventional Techniques

Depending on the nature of the application and the strength of the internal data patterns you can generally expect a network to train quite well. This applies to problems where the relationships may be quite dynamic or non-linear. ANNs provide an analytical alternative to conventional techniques which are often limited by strict assumptions of normality, linearity, variable independence etc. Because an ANN can capture many kinds of relationships it allows the user to quickly and relatively easily model phenomena which otherwise may have been very difficult or impossible to explain otherwise.
6 CONCLUSION

This paper thus makes use of the capabilities of Artificial Neural Networks to generate the possible Specific Fuel consumption and emissions of NOX and HC for the entire range of blends of the given Biodiesel with petroleum derived diesel. Since the properties of the Biodiesel has been included as an input the network is generalized and could be used for the prediction of the variation in performance and emission characteristics with respect to the blending ratio for any Biodiesel.

References


