A STUDY ON SHORT TERM LOAD FORECASTING USING BACK PROPAGATION NEURAL NETWORK

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May 2010

"I hereby declared that I have read through this report entitle " A Study On Short Term Load Forecasting Using Back Propagation Neural Network " and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

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A report submitted in partial fulfillment of requirements for the degree of Bachelor In Electrical Engineering (Industrial Power)

Fakulti Kejuruteraan Elektrik
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MAY 2010

"I declare that this report entitle *"Short Term Load Forecasting Using Back Propagation Neural Network Algorithm"* is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : ABDUL HASIF BIN ABDUL HALIM

Date :

Dedicated to my beloved Mother and Father, my siblings
and all my friends
for their love and sacrifice.

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In the name of Allah S.W.T, the most gracious and merciful, praise to Allah the lord of universe and may blessing and peace of Allah be upon his messenger Muhammad S.A.W. First, and foremost thank to Allah for giving me wellness and ideas to complete this project report. Without any of it, I surely cannot complete this project in the time given.

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ABSTRACT

Artificial Neural Networks (ANN) has been applied to many fields in recent years. Among them, the neural networks with Back Propagation algorithm appear to be most popular and have been widely used in applications such as forecasting and classification. This project is to predict or forecast the load flow for economic dispatch by using ANN. The main objective of this project is to develop ANN model that will give a faster result compared with conventional method. The load forecasting is an important component in the operation and planning of electrical power generation. In order to minimize the operating cost, an electrical supplier will use a forecasted demand to control the number of running generator units. The short-term load forecasting (STLF) provides load data in hourly forecasting and it is important for daily maintenance of power plant. This project will predict future load data is peninsular Malaysia. The input that will use for forecasted are is half hourly load data for seven weeks and the actual load data that used for compared are was loaded data from eight week. The end of this project, the result between forecasted load data using Matlab will compared with actual load data to get the error and to achieve the minimum forecasting error.

ABSTRAK

Jaringan Saraf Buatan (ANN) telah diperkenalkan dalam perbagai bidang sejak bertahun-tahun yang lepas. Antaranya, jaringan saraf dengan kaedah algoritma Penyebaran kebelakang adalah paling mudah dan telah digunakan dengan meluas dalam aplikasi seperti peramalan dan pengelasan. Projek ini adalah untuk meramalkan atau mengandaikan aliran beban dengan menggunakan satu rangkaian neural buatan (ANN). Projek ini juga adalah untuk membangunkan ANN yang akan memberi keputusan yang cepat berbanding dengan kaedah biasa. Peramalan beban adalah satu komponen penting dalam operasi dan perancangan penjanaan kuasa elektrik. Dengan tujuan meminimumkan kos operasi, sesebuah syarikat pembekal elektrik akan menggunakan data yang diramalkan untuk mengawal jumlah unit penjana yang akan beroperasi. Peramalan Beban Jangka Pendek (STLF) memberikan peramalan data beban dalam setiap jam dan ia amat penting untuk penyengaraan harian bagi sesebuah jana kuasa. Projek ini akan meramalkan beban akan datang bagi semenanjung Malaysia. Beban masukkan yang digunakan adalah daripada data setiap setengah jam untuk tujuh minggu dan data sebenar untuk membuat perbandingan adalah daripada data beban minggu ke lapan. Pada akhir projek ini, keputusan data diantara data beban ramalan menggunakan Matlab dan data sebenar akan dibandingkan untuk mendapatkan ralat sehingga mencapai ralat ramalan yang rendah.

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LIST OF ABBREVIATION

STLF		Short Term Load Forecasting
ANN		Artificial Neural Network
BPNN	-	Back Propagation Neural Network
FFNN	-	Feed Forward Neural Network
MLP	-	Multilayer Perceptron
PE	-	Processing Element
AME	-	Absolute Mean Error
MAPE		Mean Absolute Percentage Error
MW	-	Megawatt
GW	-	Gigawatt
ARMA	-	Automatic Regressive Moving Average
MV	-	Moving Average
NN	-	Neural Network

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CHAPTER 1

INTRODUCTION

1.1 Objectives

The objectives of this project are:

1) To study and analyze the characteristics of load data taken.
2) To use important architectures of Neural Network, Back Propagation model for short term load forecasting.
3) To do the simulation and analysis using Matlab software for forecasting load data.
4) To develop ANN that will give a faster result compared with conventional method.
5) To predict the future load within 24 hours for a day or a week with to find minimum forecasting error.

1.2 Problem statement

The total amount of electricity power consumed by people must be balanced with the amount of generated power. There is no efficient way to store large amounts of electricity energy. To maintain this power balance between production and consumption, it should be forecast future power needs. A broad spectrum of factors affects the system load level such as trend effects, cyclic-time effects, weather effects and also random effects like human activities, load managements, and thunderstorms.

In order to supply high quality electric energy to the customer in a secure and economic manner, an electric company faces many economical and technical problems in operation, planning, and control of an electric energy system. For the purpose of optimal planning and operation of this large scale system, modern system theory and optimization techniques are being applied with the expectation of considerable cost savings. In achieving this goal, the knowledge of future power system load is the first prerequisite; therefore, short-term load forecasting is very important to forecast future load data. [2][3]

Many methods have been used for load forecasting in the past. This includes statistical methods such as regression, fuzzy logic, expert systems and vector machines. An artificial neural network back propagation has been used in this project. The back propagation algorithm used to change or adjust the weights of the neural network. In back propagation, the gradient vector of the error surface is calculated. This vector points along the direction of steepest descent from the current point, so that a movement over a short distance along the vector decreases the error. A sequence of such moves will eventually find a minimum error point. [2]

1.3 Scope of work

The performance and reliability of Artificial Neural Network (ANN) depends on several factors which include the quality of training data, the initial weights used, the network structure and the activation function used. The trained network then can make a prediction based on the relationships learned during training. For this project, Back Propagation Neural Network (BPNN) method will be used to predict the future load in Peninsular Malaysia within 24 hours for a day or a week ahead, to find minimum forecasting error.

The load data in two month will be used in training and testing process. The input that used for forecasted are is half hourly load data for seven weeks and the actual load data that used for compared are was loaded data from eight week. Matlab software will be used to simulate and analysis forecasting load data. The result between forecasted loads data using Matlab will compare with actual load data to find forecasting error.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This project will focus on application of Artificial Neural Network to forecast or predict the load flow for economic dispatch. Neural networks have seen an explosion of interest over the few years and are being successfully applied across an extraordinary range of problem domains, in areas as diverse as finance medicine, engineering, geology and physics. Indeed, anywhere that there are problems of prediction, classification or control, neural networks are being introduced. Neural networks could be defined as an interconnection of simple processing elements whose functionality is based on the biological neuron. Biological neuron is a unique piece of equipment that carries information or a bit of knowledge and transfers it to other neurons in a chain of networks. The following studies were reviewed to gain an idea in doing this project.

2.2 Background

Artificial Neural Networks (ANNs) refer to a class of models inspired by the biological nervous system. The models are composed of many computing elements, usually denoted neurons and each neuron has a number of inputs and one output. It also has a set of nodes called synapses that connect to the inputs, output, or other neurons. [1]

Most ANN models focused in connection with short-term forecasting use Multi-Layer Perceptron (MLP) networks. The attraction of MLP can be explained by the ability of the network to learn complex relationships between input and output patterns, which would be difficult to model with conventional methods.

A number of different models intended to initiate some function of human brain, using certain part of it basic structure described as neural network. It consists of large number of simple processing elements called neurons or nodes or simply processing units which are interconnected to each other. It also can be described as black box device such as shown in figure 2.1. [2]

Figure 2.1: Black box device

2.3 The Components of Back Propagation Algorithm

Back propagation was created by generalizing the Widrow-Hoff learning rule to multiple-layer networks and nonlinear differentiable transfer functions. Input vectors and the corresponding target vectors are used to train a network until it can approximate a function, associate input vectors with specific output vectors, or classify input vectors in an appropriate way as defined. The term back propagation refers to the manner in which the gradient is computed for nonlinear multilayer networks. There are a number of variations on the basic algorithm that are based on other standard optimization techniques, such as conjugate gradient and Newton methods.

The simplest implementation of back propagation learning updates the network weights and biases in the direction in which the performance function decreases most rapidly, the negative of the gradient. One of iteration of this algorithm can be written as

$$X_k + 1 = X_k - \alpha_k g_k \tag{2.1}$$

Where X_k is a vector of current weights and biases, g_k is the current gradient, and α_k is the learning rate.

2.3.1 Input and Output Factor

During applying back propagation algorithm to the problem, selection of input is the most important part that has an impact on the desired output. In Back Propagation Neural Network (BPNN) the neurons in the input layer are not neurons in processing elements (PEs) sense, they act as simple fan out devices which passes the input to the various neurons in the next (hidden) layer without doing any processing. Therefore, the number of input layer neurons is fixed by the number of scalars in the input vector. As each neuron provides only a single output, the number of neurons required in the output layer will be equal to the number of scalars in the output vector. Improper selection of input will cause divergence, longer learning time and inaccuracy reading, that is greater than 1.

2.3.2 Weighting Factor

Relative weighting will be installing in each input and this weighting will affected the impact the input as shown in Figure 2.2. Weights determine the intensity of the input signal and are adaptive coefficients within the network. To various input, the initial weight for PE can be modified and according to the network's own rules for modification.

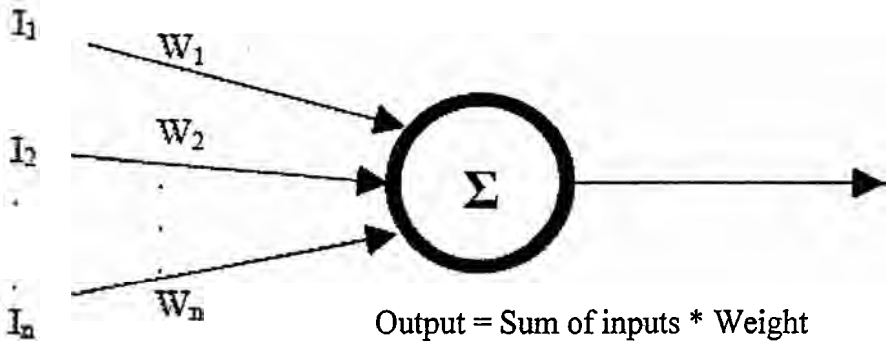

Figure 2.2: Simple summation function to determine the output

The inputs and the weights on the inputs can be seen as vectors mathematically, such as (I_1, I_2 ... I_n) and (W_1, W_2 ...W_n). Each component of I vector by corresponding component of the W vector and add up the entire product as an example : (Input 1 = I_1 * W_1). Then all these input are added to give the scalar result.[8]

2.3.3 Neuron Model

Neuron also known as a processing element and several important activities are taking place within the design of this processing element. The summation function was examined first which is represented in Figure 2.2 and Figure 2.3. It will be more than a simple summation after all products was summed and then was compared to some threshold to determine the output. If the threshold is less than the sum of the output, the processing element generates a signal. If the threshold is greater than the sum of the inputs, there is no signal was generated.

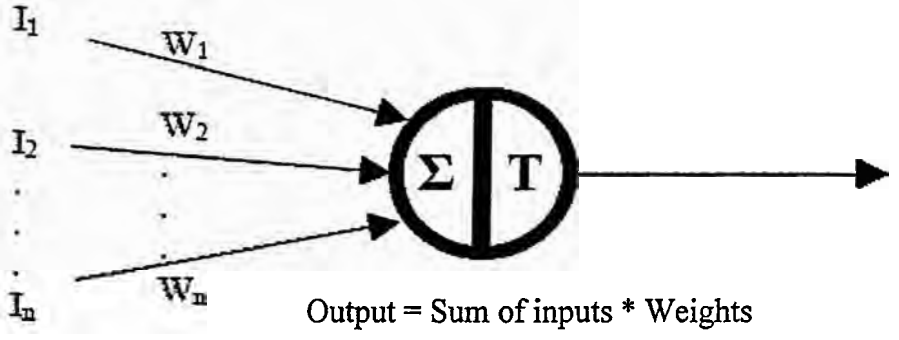

Figure 2.3: Summation functions that is compared to the threshold to determine output