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A STUDY ON SHORT TERM LOAD FORECASTING

MOHD ZULHAFIZ BIN MOHD JOHARI

A report submitted in partial fulfillment of requirements for the degree of bachelor in electrical engineering (industrial power)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

JULY 2009

I declared that this report entitle “a study on short term load forecasting” is the result on 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 : **MOHD ZULHAFIZ BIN MOHD JOHARI**

Date : **10 JULY 2009**

Especially dedicated to my beloved mother and father. Thanks for your love and support.

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Bissmillahirahmanirahim. 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. Thanksgiving to Allah because He has give me opportunity to complete my final year project and final year report. Without His blessing, I sure can't complete this task in the time given.

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ABSTRACT

This project is to forecast or predict the load flow for economic dispatch by using the single artificial neural network (ANN). This project also is to develop ANN that will give a faster result compared with conventional method. Several ANN parameters will be used such as learning rate, momentum rate, number of hidden layers and nodes and training function. The Back Propagation which consists of multi-layered perception model makes possible to train the ANN training patterns. As an input, the load data of 24 hours has been developed and its output is the next 24 hours of the load. After doing testing with the optimum training network, the network will give the desired output of the load forecasting.

ABSTRAK

Projek ini adalah untuk meramalkan atau mengandaikan aliran beban untuk kesegeraan ekonomi menggunakan satu rangkaian neural buatan (ANN) . Projek ini juga adalah untuk membangunkan ANN yang akan memberi keputusan yang cepat berbanding dengan kaedah biasa. Beberapa parameter ANN akan digunakan seperti *learning rate, momentum rate,* bilangan *hidden layers* dan juga *training function.* Rangkaian suap balik yang mengandungi model peceptron pelbagai lapisan membolehkan ia mempelajari bentuk pelajaran ANN. Sebagai masukan,data beban 24 jam telah dibina dan keluaran ia adalah data 24 jam selepasnya. Selepas melakukan percubaan(*testing*) dengan nilai rangkaan pembelajaran(*training*) yang optimum, rangkaian ini akan memberikan keluaran yang dikehendaki untuk ramalan beban.

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LIST OF ABBREVIATION

TNB	-	Tenaga Nasional Berhad
STLF	-	Short Term Load Forecasting
ANN	-	Artificial Neural Network
MLP	-	Multilayer Perceptron
PE	-	Processing Element
AME	-	Absolute Mean Error
MW	-	Megawatt
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 learn on short term load pattern based on data collection. The load data was collected from Tenaga Nasional Berhad (TNB).
2. To forecast or predict the load flow for the next 24 hours for economic dispatch by using ANN.
3. To develop ANN using back propagation method that will give a faster result compared with conventional method.

1.2 Problem Statement

Nowadays, the electrical load increase about 3-7% per year for many years. At the present time, conventional method gives a longer time to make a prediction. STLF is important to supplier because they can use the forecasted load to control the number of generators in operation either shut up some unit when forecasted load is low or start up of new unit when forecasted load is high.

By using Artificial Neural Network, this project will show how to forecast or predict the next 24 hours load data.

1.3 Scope of Work

For this project, the scope covered on short term load forecasting (STLF). Short term load forecasting means that the forecaster calculates the estimated load for each hours of the day, the daily peak load, or the daily or weekly energy generation.

In this project, the load data in 3 month will be used in training and load data for the next 3 month will be used in testing. The input load data will be load on Saturday, Monday, Wednesday, and Friday. Meanwhile, the target load data will be load on Sunday, Tuesday, Thursday, and Saturday. The parameter that used in this project are learning rate, momentum rate, maximum number of iteration (epoch) and the minimum error goal. The training performance must be 100 percent. If the 100 percent performance was not meet, then the parameter will be adjusted to get the 100 percent performance during training.

The quality of training data, the initial weights used, and the network structure used will give the performance and reliability of Artificial Neural Network (ANN). The trained network can then make prediction based on the relationships learned during training.

1.4 Background

1.4.1 Artificial Neural Network

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 can also describe as black box device, processing information coming in and producing a certain output. [2]

Figure 1.1: Black box device

1.4.1.1 The Components of ANNs

Commonly neural networks are adjusted or trained, so that a particular input leads to a specific target output. Such a situation is shown below. There, the network is adjusted, based on a comparison of the output and the target, until the network output matches the target. Typically many such input or target pairs are needed to train a network.

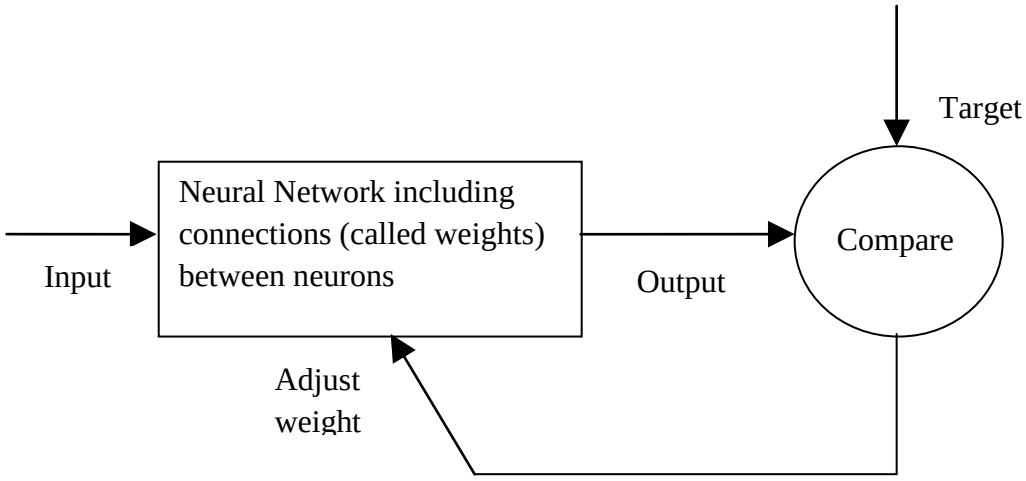

Figure 1.2: Component of ANN

1.4.1.2 The 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

$$X_k + 1 = X_k - \alpha_k g_k \qquad \text{Equation(1.1)}$$

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

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. A set of load data is chosen in a case of classification problem. The following studies were reviewed to gain an idea in doing this report.

2.2 The Components of ANNs

Commonly neural networks are adjusted or trained, so that a particular input leads to a specific target output. Such a situation is shown in figure below.

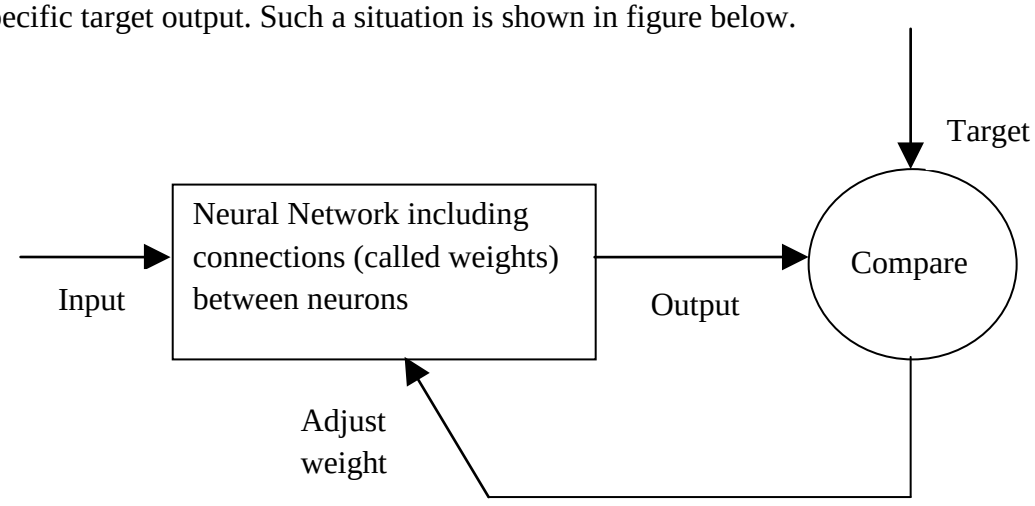

Figure 2.1: Basic Component of ANN

There, the network is adjusted, based on a comparison of the output and the target, until the network output matches the target. Typically many such input or target pairs are needed to train a network.

2.2.1 Input and Output Factor

During applying back propagation algorithm to the problem, selection of input is very important part that has an impact on the desired output. If there is much input to a neuron, there should be as many input signal in processing elements (PEs).

Selection input in improper will cause divergence, longer learning time and inaccuracy reading, greater than 1.

2.2.2 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.

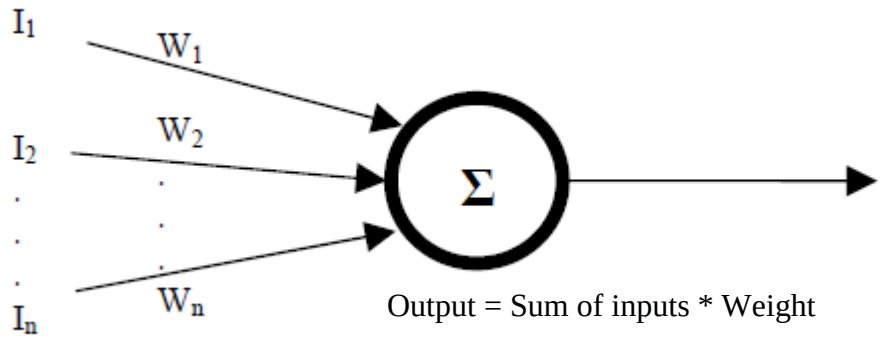

Figure 2.2: Simple summation function to determine the output

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.

2.2.3 Neuron Model

A neuron also known as a processing element and several important activities take 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.

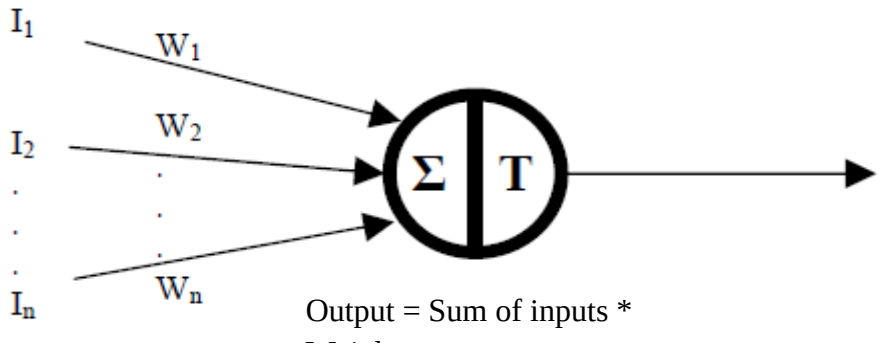

Figure 2.3: Summation functions that is compared to the threshold to determine output

2.2.4 Transfer Function

There are many transfer function and basically the transfer function is a non-linear. The linear also known a straight line and the linear function is limited because the output is proportional to the input. Although, the output is depends upon whether the result of summation is negative or positive. The network output can be 1 and -1, or 1 and 0.

The hard limiter transfer function was used in perceptrons to create neurons that make classification decisions. For the linear transfer function, neurons of this type are used as linear approximators in linear filters. The sigmoid transfer function takes the input which can have any value between positive and negative infinity, and squashes the output into the range 0 to 1.