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Electricity Demand Estimation Using an Adaptive Neuro-Fuzzy Network: A Case Study from the State of Johor, Malaysia

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Abstract
Electricity is one of the energy types that have attracted a lotof interest due to its versatility.Rigorous analysis of the determinants of electricity demand as well as its accurate forecasting are of vital importance in the design of an effective energy policy to deal with current and future electricity needs.Several load forecasting models have been used inelectric power systems for achieving accuracy. Most studies have focused on the relationship between electricity demand and economicparameters such as gross domestic product (GDP), Gross National Product (GNP), national income, and the rate of employment as well as unemployment. Various studies have investigated the influence of ambient airtemperature, most times represented by heating and coolingdegree-days, on electrical energy consumption. Many studies have been conducted on short/long term electricity demand/load forecasting, but application of neuro fuzzy logic for forecasting electricity demand based on combined economic and climate conditions is still unexplored. In this paper, an ANFIS network (adaptive neuro fuzzy inference system) was designed to map six parameters as input data for State of Johor, Malaysia including four demographic& economic parameters (i.e. Employment, GDP, Industry Efficiency and Population), and two meteorological parameters related to annual weather temperature (i.e. minimum and maximum average annual temperature).to electricity demand as output variable.

Keywords: Electricity demand; Neuro-Fuzzy; ANIFS; Forecasting

1. Introduction

The current electricity demand/load forecasting methods are mostly based on: data mining, multivariate analysis and time series analysis [1-10]. Multivariate analysis establishes the relationship between dependent and independent variables and fashions a causal model for dependent variable forecasting in term of independent variable. The forecasting precision of this model depends on the selection of independent variables. If the variation of the dependent variables cannot effectively explain, then it will produce a forecast model with high variance. On the other hand, time series models require only the historical data of the variable of interest to forecast its future progression. For example, the autoregressive integrated moving average (ARIMA) models have been widely used in energy demand forecasting. However, a large number of observations have been usually required to produce accurate forecasting results. Data mining techniques, such as artificial neural networks and support vector regression, are widely used as forecasting approaches and have extremely good forecasting performance. However, the forecasting results depend on the number of training data and their representativeness, and these limitations have not yet been overcome.

In all the above methods, the key element that affects forecasting performance is the sample size, which limits their applicability to certain forecasting situations. Forecasting the energy demand in rapidly developing countries is an example of this. Although a considerable amount of historical data is available, it usually differs significantly from the actual growth in electricity consumption. Since electricity consumption is generally represented as following an exponential trend, the usual methods of forecasting with limited data, such as basic time-series approaches like the moving average, exponential smoothing, and linear regression, are not suitable. Therefore, for a non-deterministic condition, it is helpful to establish new models using limited samples to conduct electricity consumption forecasting. The currently applied theories and methods for non-deterministic data or uncertainties can be divided into three categories: probability theory, fuzzy mathematics, and grey system theory [11-15]. Where probability theory focuses on the stochastic phenomena [16], fuzzy mathematics studies the situation of cognitive