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A research on short term load forecasting problem applying improved grey dynamic model

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ABSTRACT

The grey dynamic model GM(1, 1), which is based on the grey system theory, has recently emerged as a powerful tool for short term load forecasting (STLF) problem. However, GM(1, 1) is only a first order single variable grey model, the forecasted accuracy is unsatisfactory when original data show great randomness. In this paper, we propose improved grey dynamic model GM(2, 1), a second order single variable grey model, to enhance the forecasted accuracy. Then it is applied to improve STLF performance. We provide a viewpoint that the derivative and background value of GM(2, 1) model can be expressed in grey number. Then cubic spline function is presented to calculate the derivative and background value in grey number interval. We call the proposed model as 3spGM(2, 1) model. Additionally, Taylor approximation method is applied to 3spGM(2, 1) for achieving the high forecasted accuracy. The improved version is defined as T-3spGM(2, 1). The power system load data of ordinary and special days are used to validate the proposed model. The experimental results showed that the proposed model has better performance for STLF problem.

1. Introduction

The short term load forecasting (STLF) problem has been widely studied in the fields of electrical power and energy systems. The reason is that accurate forecasting can help in the real-time power generation, efficient energy management, and economic cost saving [1]. Up to present, proposed methods for STLF problem can be roughly divided into four types: time series method, regression method, expert-based method and neural network based method. However, the successes of these methods rely on a law for the distribution of original series or a large amount of observed data [2]. Therefore, they are often difficult to carry out and are not even feasible due to cost considerations [3].

We can change our attribute and look at the real world from a different angle, system dynamics can be treated from the viewpoint of the degree of information availability, we would walk out from the shadow of large sample statistics. In modern control theory, system dynamics are classified by the degree of information completeness. In 1982, Deng proposed grey system theory [4] to study the uncertainty of system. In grey system theory, according to the degree of information, if the system information is fully known, the system is called a white system, while the system information is unknown, it is called a black system. A system with partial information known and partial information unknown is grey system. It avoids the inherent defects of conventional, large sample statistical methods, and only requires a limited amount of discrete data to estimate the behavior of a system with incomplete information.

The grey model (abbreviated as GM) based on the grey system theory is a forecasting dynamic model and has been applied to many forecasting fields. The GM has three properties: first, it does not need a large amount of sample data. Second, its calculation is simple. Third, it can use random sample data. Since 1980s, the methods based on GM is getting more and more attention for its promising results in STLF. In the beginning, researchers are trying to demonstrate the feasibility of applying GM to STLF problem in power engineering. Recently, efforts are put to improve the forecasting performance of GM. A wide variety of methods to improve STLF performance have been reported as in [5–15] which include combining with ARIMA model or neural network, error compensation and data preprocessing etc. However these methods are only proposed based on GM(1, 1) which stands for the first order grey model with one variable. It has been pointed out that GM(1, 1) is unsatisfactory when original data shown great randomness [16]. Up to present, GM(2, 1), a single variable second order grey model, has been not yet applied to resolve STLF problem in power engineering. It has been indicated that GM(2, 1) model has very serious

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