Chapter 44

Comparative Analysis of Statistical, Machine Learning, and Grey Methods for Short-Term Electricity Load Forecasting

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ABSTRACT

Electricity load forecasting is crucial for electricity generation companies, distributors and other electricity market participants. In this study, several forecasting techniques are applied to time series modeling and forecasting of the hourly loads. Seasonal grey model, support vector regression, random forests, seasonal ARIMA and linear regression are benchmarked on seven data sets. A rolling forecasting model is developed and 24 hours of the next day is predicted for the last 14 days of each data set. This day-ahead forecasting model is especially important in day-ahead market activities and plant scheduling operations. Experimental results indicate that support vector regression and seasonal grey model outperforms other approaches in terms of forecast accuracy for day-ahead load forecasting.

INTRODUCTION

Electricity is an unstorable energy resource. This increases the importance of timely and accurate management in the electricity market. As well as the profitability of the electricity market as a social obligation it must be operated properly. In this context, load forecasting has become a process that must be performed successfully for the companies. Jabbour et al. (1988) identifies several areas of usage for load forecasting, including;

- Setting the spinning reserve.
- Maintenance scheduling.
- Economically operating the generators and the transmission system.
- System security studies.
- Contingency planning and load management scheduling.
- Determining the tie and interchange schedules among interconnected utilities.
- Demand side management.
- Preparing for unusual events.
- Optimizing the cost of fuel inventory.
- Load flow studies.

In literature electricity load forecasting is divided into three categories in terms of the time horizon under consideration. These are long, medium and short terms. The first category includes long term load forecasting. The time span in consideration can be six months, one year or longer. It is particularly important for growth strategies at the government level and also it has importance on the strategic decision making process of the electricity market operators. The second category deals with medium term load forecasting. The time span is weeks or months. It is vital for electricity generation companies because the stock levels and resource management decisions need this information (Hoffman & Wood, 1976). The last category is short term, hourly load forecasts. The short-term forecasts refer to hourly prediction of electricity load demand for a lead time ranging from 1 hour to several days ahead. In certain instances, the prediction of the daily peak load is the objective of short-term load forecasting, since it is the most important load during any given day (Niu et al., 2010). Hourly load forecasting of the next day is a crucial operation in electricity markets. All market players need this information to make a bidding decision on the market. Also, this information is vital for electricity production and distribution companies.

These requirements to the load forecasting have led to the development of many load forecasting methods. Basic and advanced statistical methods, artificial intelligence based methods, grey theory based methods and recently machine learning methods are applied to the load forecasting. Because of its difficulty due to the complexity of the prediction of the variables that effect the demand (such as temperature) and the high cost of the mistakes, load forecasting is still an area being heavily worked on where new algorithms developed constantly. This study will investigate the performances of the prominent forecasting techniques on short-term load forecasting. Literature shows that the statistical models are dominant in the past. However, today these statistical models have left their places to the more sophisticated statistical techniques, machine learning techniques and to advanced methods such as grey systems. There are very few studies about these methods in load forecasting. In this study performances of the grey models and support vector regression (SVR) and random forest techniques which are known to be very strong forecasting algorithms in the field of machine learning, will be investigated.

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