Chapter 12
Electricity Demand Forecasting using Dual Stream TBATS-CNN-LSTM Architecture

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ABSTRACT

The problem is the model's reliability, accuracy, and meaningfulness to convince decision-makers of the actions to be taken when seasonality is one of the features in the findings of the existing deep learning forecasts. The purpose of this chapter is to come up with a novel dual-stream hybrid architecture that is capable of predicting electricity demand and accessing its accuracy levels by benchmarking it with individual architecture model's forecasting accuracy levels using out-of-sample time series. The approach in this chapter uses time series and convolutional neural network (CNN)-based long short-term memory with various configurations to construct a forecasting model for short- to medium-term aggregate load forecasting. The obtained results show that the TBATS-CNN-LSTM-based model has shown high accuracy as compared to the base learner, and the model is optimised with hyperparameter tuning. Only optimally selected time-lag features captured all the characteristics of complex time series in South Africa.

INTRODUCTION

In modern society, electricity has become a central part of everyday life, so the economic growth of any country is closely related to its electricity infrastructure, electricity grid, and availability. Therefore, the

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global demand for residential and commercial energy has increased enormously. Meanwhile, electricity prices have fluctuated in recent years, not to mention inadequate power generation to meet global demand. To address this issue, many studies have focused on estimating future residential and commercial electricity demand so that electricity producers, distributors, and suppliers can effectively plan and promote energy conservation for users. Electricity is the pivot in upholding highly technologically advanced industrialisation in every economy. (See, for instance, Aung, (2018) and Hussain et al. (2016)). Almost every activity done in this modern era hinges on electricity. The demand and usage of electric energy have increased globally in the past few years (Jevgenijs et al., 2019). However, the process of generating, transmitting, and distributing electrical energy remains complicated and costly. Hence, effective grid management plays an essential role in reducing the cost of energy production and increasing the capacity to meet the growing demand for electric energy (Uz Zaman et al. 2018). Therefore, effective network management includes adequate load demand planning, adequate maintenance programs for generation, transmission, and distribution networks, and efficient load distribution in the supply network. Therefore, accurate load forecasting has a great impact on maximizing the efficiency of the planning process in the power generation industry (Kumar and Veerakumari, 2012). Several computational and statistical methods have been used to improve forecasting models as a means of increasing the accuracy of electricity demand (EDD) forecasts (Nti et al., 2019).

Uncertainties in energy supply and demand can cause grid instability issues such as power surges and frequency fluctuations. To overcome these situations, the system must be flexible and resilient, able to cope at all times with rapid changes in generation and load, and maintain balance. In this regard, modern technologies, and approaches such as small-scale energy storage systems (e.g., batteries) and demand response programs are receiving increasing attention (International Energy Agency, 2020). However, this is not always possible, as it is very expensive and still requires improvements for widespread use. On the other hand, a common way for system operators to deal with this variability is to define a certain amount of energy reserves that can be used to adjust the system frequency. In liberalized markets such as the Iberian Electricity Market (MIBEL), the need for and use of this energy reserve can lead to additional costs for system operation and increased energy prices.

What the above solutions have in common is that they try to manage system variability by reacting immediately to momentary fluctuations such as battery discharge, appliances turning off, or generator power increasing. However, they usually planned their activities based on forecasts of power production and load demand. Therefore, accurate predictions are essential to optimizing the performance of these tools and the performance of the entire system (Machado et al., 2021). The interest in energy demand and supply forecasts has significantly increased since the oil crisis in the 1970s (International Energy Agency, 2020). At that time, most of the employed models were statistics-based, such as linear regression, ordinary least squares, and stepwise regression, among others. However, the growing complexity of electrical systems and the unknown relationships between multiple variables impose great difficulties that these simpler models cannot handle. On the other hand, a boost in the application of computational methods has been observed in recent years. The technological developments in computing allowed the creation of sophisticated and efficient computational methods that typically use advanced statistical concepts. They can be combined with statistical models and used to estimate their parameters or to make forecasts with reduced computational time and improved performance (International Energy Agency, 2020).

Therefore, in the present chapter, combined deep learning forecasting-based TBATS-CNN-LSTM for hourly electricity demand load forecast is proposed. The main novelty of this method is that the base learners, namely TBATS, convolutional neural network (CNN), and long-short-term memory (LSTM),

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