Electricity Demand and Price Forecasting Using Machine Learning Techniques

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*Abstract*—This project presents a comparative study of machine learning techniques for electricity demand and price forecasting. A dataset from Kaggle, covering 2106 days between 1st January 2015 to 6th October 2020, is used to train and test models. The dataset contains 14 columns, including demand, RRP, temperature, solar exposure, rainfall, and holiday information. After preprocessing and feature engineering, the dataset is split into training and testing sets. Two machine learning models, LSTM and Random Forest, are implemented and compared. The results show that the Random Forest model achieves an accuracy of 94.4%, outperforming the LSTM model with an accuracy of 96.74%. This study contributes to the development of accurate and reliable models for electricity demand and price forecasting.

Keywords— Electricity demand prediction, Machine learning algorithms, Energy forecasting.

INTRODUCTION

Accurate prediction of electricity demand and pricing is crucial for energy management and economic planning. This study employs machine learning techniques, specifically Long Short-Term Memory (LSTM) and Random Forest models, to forecast electricity consumption and prices. The research compared the performance of these two advanced predictive models, with Random Forest achieving an accuracy of 94.4% and LSTM demonstrating superior performance at 96.74%. The high accuracy of both models, particularly the LSTM approach, suggests the potential of machine learning algorithms in providing reliable electricity demand and price predictions. These findings contribute to more efficient energy resource allocation, grid management, and economic decision-making in the electrical power sector.

The electrical power sector plays a critical role in modern economic infrastructure, with electricity demand and pricing serving as key indicators of economic activity and energy resource management. Accurate forecasting of electricity consumption and prices has become increasingly important for utility companies, policymakers, and energy traders to optimize resource allocation, manage grid stability, and make informed financial decisions.

Traditional forecasting methods often struggle with the complex and dynamic nature of electricity markets, characterized by multiple influencing factors such as weather conditions, economic indicators, seasonal variations, and technological changes. Machine learning techniques have emerged as powerful tools to address these challenges offering advanced predictive capabilities that can capture intricate patterns and relationships within large datasets.

This research focuses on developing predictive models using two prominent machine learning algorithms: Long Short-Term Memory (LSTM) neural networks and Random Forest. LSTM, a type of recurrent neural network, is particularly effective in capturing time-series dependencies, while Random Forest provides robust ensemble learning capabilities. By implementing and comparing these models, the study aims to demonstrate the potential of machine learning in electricity demand and price forecasting.

The primary objectives of this research include:

- Developing accurate predictive models for electricity demand and pricing

- Comparing the performance of LSTM and Random Forest algorithms

- Investigating the potential of machine learning techniques in energy forecasting

Through a comprehensive analysis, the study achieved notable results, with the Random Forest model attaining 94.4% accuracy and the LSTM model reaching an impressive 96.74% accuracy. These findings highlight the significant potential of advanced machine learning approaches in addressing the complex challenges of electricity market prediction.

## **Literature Review**

*Overview of Existing Methods*

Electricity demand and price forecasting have been extensively studied in the literature. Traditional methods, such as ARIMA [1] and SARIMA [2], have been widely used for forecasting electricity demand and prices. However, these methods have limitations in handling non-linear relationships and complex patterns in the data.

*Machine Learning Approaches*

In recent years, machine learning approaches have gained popularity in electricity demand and price forecasting. Techniques such as Artificial Neural Networks (ANNs) [3], Support Vector Machines (SVMs) [4], and Gradient Boosting [5] have been used to improve forecasting accuracy.

*LSTM and Random Forest Models*

LSTM and Random Forest models have been widely used in time series forecasting. LSTM models are particularly effective in handling sequential data and can learn long-term dependencies. Random Forest models are ensemble models that can handle complex patterns in the data.

**Methodology**

*Data Description*

The dataset used in this project is from Kaggle, covering 2106 days between 1st January 2015 to 6th October 2020. The dataset contains 14 columns, including:

- Date

- Demand

- RRP

- Demand\_pos\_RRP

- RRP\_negative

- Demand\_neg\_RRP

- RRP\_Positive

- Frac\_at\_neg\_RRP

- Min\_temperature

- Max\_temperature

- Solar\_exposure

- Rainfall

- School\_day

- Holiday

*Data Preprocessing*

The dataset is preprocessed by converting the date column into day, month, year, and day of the week. The values are then scaled using the Min-Max Scaler, handled missing values, encoded categorical values. And after preprocessing total number of columns are 18

*Data Visulisation*

*To better understand the relationships between variables, I created various plots, including:*

*- Scatter plots to visualize demand vs. max-temperature and demand vs. RRP, demand vs solar exposure*

*- Box plot to analyze demand by day of a week, demand on school days vs holidays*

*- Joint plots to examine relationship between demand vs RRP*

*- Histograms to analyze the distribution of demand and temperature values*

*- Correlation heatmap*

*These visualizations provided valuable insights into the data and informed our modeling decisions.*

*Feature Engineering*

The dataset is split into training and testing sets using the train\_test\_split function from Scikit-learn.

*Model Implementation*

Two machine learning models, LSTM and Random Forest, are implemented and compared.

- LSTM: The LSTM model is implemented using the Keras library. The model consists of an input layer, a LSTM layer, and an output layer

- Random Forest: The Random Forest model is implemented using the Scikit-learn library. The model consists of an ensemble of decision trees.

**Results and Discussion**

*Results*

The results of the two models are compared in terms of accuracy.

- LSTM: The LSTM model achieves an accuracy of 96.74%.

- Random Forest: The Random Forest model achieves an accuracy of 94.4%.

*Discussion*

The results show that the LSTM model outperforms the Random Forest model in terms of accuracy. This is because the LSTM model is particularly well-suited for handling sequential data with complex patterns and temporal relationships. The LSTM model's ability to capture temporal dependencies, learn non-linear relationships, and extract relevant features from the input data contribute to its superior performance. Additionally, the LSTM model's ability to handle missing values in the input data makes it more robust than the Random Forest model. Overall, the LSTM model is a better choice for electricity demand forecasting due to its ability to handle the complexities of the data.

**Conclusion**

*Summary of Key Findings*

The LSTM model achieves an accuracy of 96.74%, outperforming the Random Forest model with an accuracy of 94.4%.

*Implications and Recommendations*

The results of this study have implications for utilities and policymakers. The use of machine learning models, such as LSTM, can improve the accuracy of electricity demand and price forecasting, leading to more efficient resource allocation and pricing.

##### **References**

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