Forecasting Household Energy Consumption using LSTM Model

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ABSTRACT

The demand for energy, particularly electricity, has witnessed a recent global increase. Consequently, monitoring the evolution of energy consumption has become crucial. Energy consumption forecasting plays a pivotal role in utility load planning and electricity demand management. This paper aims to propose a prediction model for household electricity consumption using LSTM. The obtained results demonstrate that the proposed model exhibits feasible and reliable performance, demonstrating sufficient accuracy in predicting energy consumption, particularly in terms of hourly and daily accuracy.

Keywords: Energy consumption forecasting, Time series forecasting, LSTM

1 Introduction

Buildings have become one of the dominant sectors in energy consumption and carbon emissions, attributed to the increase in population and the improvement of human living standards. Electricity stands out as a primary form of energy consumed by buildings, with global electricity consumption reaching 27,520.5 TWh, according to studies. For instance, in the United States in 2015, over 38% of primary energy and 76% of electricity were consumed in buildings [1]. Therefore, the efficient use of electricity in buildings is crucial for reducing overall energy consumption. An effective method for accurately forecasting future electricity demand in buildings is the implementation of a home energy management system. This intelligent approach serves as a decision-making tool within energy management systems [2].

In this context, various models and methods are available for predicting future values in the time series of electricity. Studies and research have concentrated on predicting consumption by incorporating different parameters and utilizing diverse predictive models, depending on the nature of the data input and the specific goals. The prediction horizon is highly reliant on the input databases of the models, typically offering solutions on an annual, seasonal, monthly, weekly, daily, or hourly basis [3]. Our goal is to provide the most accurate predictions of second-degree consumption using three models based on hourly, daily, and weekly details.

2 Methodology

In this study, the Long Short-Term Memory (LSTM) model was employed to predict electrification based on hourly, daily, and weekly details. We examined the electrical measurements of a house situated in Sceaux (Paris, France) from December 2006 to November 2010. The raw data presented several challenges, including numerous missing values and an unsuitable recorded timeframe, which hindered forecasting accuracy. To address this, missing values were imputed by taking the mean from the relevant column in the dataset.

3 Results and Discussion

In this work, we used electric consumption data from a household dataset obtained from the UCI Machine Learning Repository [4] to evaluate the time series models. The consideration of the amount of input data is crucial to strike a balance between model accuracy and computational cost. This dataset comprises 9 columns and 2,075,259 entries.

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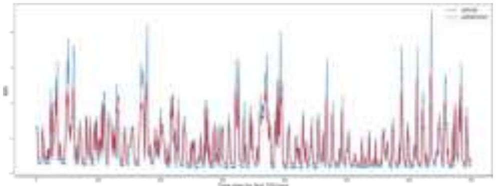
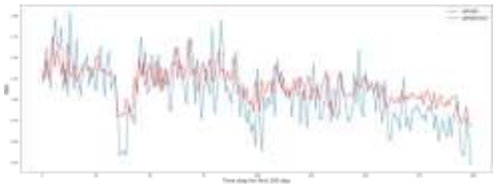
Figure 1 shows the original hourly, daily, weekly, and projected electricity consumption values obtained with the LSTM model. It is noteworthy that in the case of the hourly and daily splits, the prediction curves closely follow the fluctuations of the original electricity consumption throughout the day and night on an hourly basis, excluding certain peak usage hours. This behavior is attributed to the presence of random variations for an individual home user.

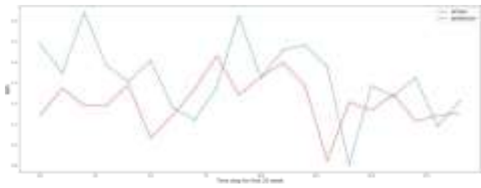
However, during a week-long observation, it was noted that the algorithm does not perform as effectively for weekly consumption when compared to hourly and daily predictions. This discrepancy may arise due to inherent fluctuations in weekly patterns.



(a)



(b)



(c)

Figure 1: *LSTM-based Electricity forecasts. (a) Hourly prediction results, (b) Daily prediction results, and (c) Weekly prediction results*

Table 1 presents the Root Mean Squared Error (RMSE) of the LSTM. The results indicate that the anticipated error values for the hourly and daily periods are lower than those for the weekly period.

Table 1: *Prediction Error Results (RMSE)*

Hourly	Daily	Weekly
0.614	0.333	0.200

4 Conclusion

Electricity consumption predictions have garnered significant attention in research, particularly with the advent of smart grid technology. Anticipating future electricity consumption is crucial for electricity service providers to manage demand cost-effectively. In this study, we employ LSTM recurrent neural networks on a housing dataset. Our objective is to identify the suitable model for forecasting household electricity consumption and determine the optimal level of forecast accuracy- whether on an hourly, daily, or weekly basis. Among the various performance metrics available for assessing model effectiveness, we selected RMSE due to its accuracy in measuring prediction error. The experimental results indicate that the LSTM model is most suitable for representing hourly and daily forecast periods, demonstrating superior prediction accuracy and efficiency. Leveraging LSTM, time series forecasting models can predict future values based on past series data, enhancing accuracy for demand forecasters and facilitating improved decision-making.

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