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HOUSEHOLD POWER CONSUMPTION ESTIMATION USING MACHINE LEARNING

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ABSTRACT

With rising electricity demand across domestic and industrial sectors and the growth of smart meter infrastructure, accurate energy consumption forecasting has become essential. Intelligent residential buildings, though convenient with remote device control, often lead to increased energy usage. To address this, an ensemble regression model combining linear prediction and Support Vector Regression (SVR) is used to enhance demand forecasting. Factors such as climate, building materials, and systems for heating, lighting, and ventilation significantly influence consumption. By utilizing historical data and advanced predictive algorithms, energy management can be optimized to reduce waste and improve efficiency across various settings.

INTRODUCTION

Energy consumption is rising due to increased domestic and industrial demands, including motor vehicles, generators, mobile devices, and household appliances. The expansion of smart meter infrastructure has facilitated the integration of active energy systems, enabling accurate forecasting and promoting greener practices. Consumer behavior and appliance usage significantly influence the electricity market, leading power grid administrations to seek innovative energy management solutions. While intelligent residential buildings offer remote control of devices, they also contribute to higher energy consumption. To enhance electricity prediction, an ensemble regression model combining linear prediction and Support Vector Regression (SVR) was developed. The misuse of home appliances results in significant energy loss annually, emphasizing the need for precise demand forecasting. Various forecasting algorithms consider factors like climate, building materials, infrastructure, and consumer behavior to improve energy predictions, leveraging historical household data from 2006 to 2010 to ensure efficient usage and sustainable power distribution.

LITERATURE SURVEY

Cognati et al. (2013) used input and output variables to estimate system parameters and develop a mathematical model, while various studies have explored machine learning techniques for energy prediction. Fu et al. (2015) applied Support Vector Machine (SVM) to predict building-level system loads, achieving an RMSE of 15.2% and MBE of 7.7%. Valgaev et al. (2016) introduced a k-Nearest Neighbours (k-NN) model for power demand forecasting, with temporal information enhancing its accuracy for 24-hour forecasts. El Khantach et al. (2019) evaluated five machine learning techniques for short-term load forecasting and found that the multi-layer perceptron (MLP) performed best with a MAPE of 0.96%, while SVM was the second most accurate. Gonzalez-Briones et al. (2019) compared various regression models, including Linear Regression (LR), Support Vector Regression (SVR), and Random Forest (RF), with LR and SVR achieving the highest accuracy at 85.7%.

EXISTING SYSTEM

We compare several regression algorithms to estimate the power consumption of an air conditioner, including multi-layer perceptron (MLP), radial basis function networks (RBFN), and support vector regression (SVR). MLP, being a conventional nonlinear regression method, serves as a strong baseline for comparison. In RBFN, each basis function acts as a hidden unit similar to MLP but with adjustable parameters. SVR, benefiting from kernel functions, excels in high-dimensional spaces. As a result, we anticipate that RBFN and SVR will yield better results compared to MLP.

PROPOSED SYSTEM

We evaluated the proposed method using a publicly available individual household power consumption dataset from the UCI Machine Learning Repository, which spans electric power consumption data from 2006 to 2010 and contains 1,048,575 rows and 9 columns. Each supervised regressor model was trained on the full training set using all features, and then evaluated on the entire test set to measure performance over time. We employed the scikit-learn implementation of logistic regression (LR), random forest (RF), and AdaBoost Regressor for this evaluation.

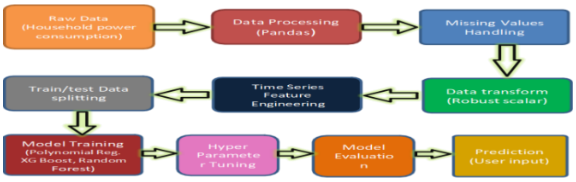
SOFTWARE REQUIREMENTS

1. Operating System: Windows 11
2. Programming language: Python
3. Version Python : 3.9.1
4. Development IDE : Jupyter Notebook
5. Data Set Information : Kaggle

HARDWARE REQUIREMENTS

1.	Processor	:Intel i5
2.	Speed (min)	:1.30 GHz
3.	Ram	:8 GB
4.	Hard Disk	:512 SSD

SYSTEM ARCHITECTURE



The Household Power Consumption Estimation using Machine Learning project involves collecting real-time and historical data on various electrical appliances' usage within a home using smart meters and IoT sensors. The data typically includes voltage, current, and time-series energy consumption readings. This data is preprocessed to handle missing values, normalize ranges, and extract relevant features. Machine learning models such as Linear Regression, Random Forest, or Support Vector Regression are then trained on this dataset to learn patterns and accurately predict the household's total power consumption. The trained model can estimate future or real-time power usage, helping in energy optimization and cost-saving decisions.

CONCLUSION

Machine learning (ML) methods have significantly advanced prediction models for power consumption, enhancing accuracy, robustness, precision, and the generalization ability of traditional time series forecasting tools. By leveraging historical data, future power consumption can be predicted more effectively. In this study, we used electric power consumption data from a household and applied linear regression and random forest regression, achieving an accuracy of 72%. Additionally, we utilized Long Short-Term Memory (LSTM) for future power consumption predictions.

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