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Machine Learning Approaches Based on Recency, Frequency, Monetary (RFM) and K-Means for Predicting Electrical Failures and Voltage Reliability in Smart Cities

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Abstract : As With the evolution of smart grids, ensuring the reliability and efficiency of electrical systems in smart cities has become crucial. This paper proposes a distinct approach that combines advanced machine learning techniques to accurately predict electrical failures and address voltage reliability issues. This approach aims to improve the accuracy and efficiency of reliability evaluations in smart cities. The aim of this research is to develop a comprehensive predictive model that accurately predicts electrical failures and voltage reliability in smart cities. This model integrates RFM analysis, K-means clustering, and LSTM networks to achieve this objective. The research utilizes RFM analysis, traditionally used in customer value assessment, to categorize and analyze electrical components based on their failure recency, frequency, and monetary impact. K-means clustering is employed to segment electrical components into distinct groups with similar characteristics and failure patterns. LSTM networks are used to capture the temporal dependencies and patterns in customer data. This integration of RFM, K-means, and LSTM results in a robust predictive tool for electrical failures and voltage reliability. The proposed model has been tested and validated on diverse electrical utility datasets. The results show a significant improvement in prediction accuracy and reliability compared to traditional methods, achieving an accuracy of 92.78% and an F1-score of 0.83. This research contributes to the proactive maintenance and optimization of electrical infrastructures in smart cities. It also enhances overall energy management and sustainability. The integration of advanced machine learning techniques in the predictive model demonstrates the potential for transforming the landscape of electrical system management within smart cities. The research utilizes diverse electrical utility datasets to develop and validate the predictive model. RFM analysis, K-means clustering, and LSTM networks are applied to these datasets to analyze and predict electrical failures and voltage reliability. The research addresses the question of how accurately electrical failures and voltage reliability can be predicted in smart cities. It also investigates the effectiveness of integrating RFM analysis, K-means clustering, and LSTM networks in achieving this goal. The proposed approach presents a distinct, efficient, and effective solution for predicting and mitigating electrical failures and voltage issues in smart cities. It significantly improves prediction accuracy and reliability compared to traditional methods. This advancement contributes to the proactive maintenance and optimization of electrical infrastructures, overall energy management, and sustainability in smart cities.

Keywords : electrical state prediction, smart grids, data-driven method, long short-term memory, RFM, k-means, machine learning
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