Enhancing Pay-As-You-Go Model for Off-grid Solar: A Particle Swarm Optimization and Random Forest Approach.

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Abstract

As the challenge of customer default persists, it continues to have a significant impact on the loan repayment sector across various industries. This issue is particularly pronounced in the Pay-As-You-Go (PAYGo) model of asset financing within the renewable energy sector, especially in off-grid communities in Africa. Under the PAYGo model, renewable energy companies provide Solar Home Systems (SHS) to customers, with payments made incrementally through mobile money channels. Defaulting on these payments directly affects the revenue of these companies, highlighting the imperative need for early prediction of potential defaulters. In this study, an innovative approach to enhance default prediction in the PAYGo model by integrating Particle Swarm Optimization (PSO) with the Random Forest (RF) and xGBoost algorithms for feature selection is introduced. Furthermore, Synthetic Minority Oversampling Techniques (SMOTE) is used to tackle class imbalance issues. The PSO algorithm, rooted in swarm intelligence, elevates classifier optimization, resulting in improved model accuracy. Primary findings reveal that the PSO-Random Forest Classifier surpasses other models in performance. The success of the PSO-RF model is attributed to its proficiency in handling complex datasets and mitigating overfitting. Through the optimization of RF hyperparameters, the PSO algorithm substantially enhances model performance. The high precision value of 0.9961 underscores the classifier's accuracy in identifying positive cases while effectively minimizing false positives (accuracy: 0.89), outperforming the unoptimized random forest (accuracy: 0.76). In summary, this research yields valuable

insights into addressing challenges related to loan repayments within the PAYGo model, thereby contributing to the sustainability and profitability of renewable energy companies operating in off-grid communities. The optimized feature selection process results in dynamic high accuracy, reducing default rates in PAYGo models for off-grid communities. These findings hold broader implications for enhancing financial sustainability and advancing renewable energy access in underserved regions, ultimately fostering economic development and environmental sustainability.

Keywords: Optimization, PSO, XGBoost, churn, Prediction,