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Machine Learning Approaches to Water Usage Prediction in Kocaeli: A Comparative Study

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Abstract : This study presents a comprehensive analysis of water consumption patterns in Kocaeli province, Turkey, utilizing various machine learning approaches. We analyzed data from 5,000 water subscribers across residential, commercial, and official categories over an 80-month period from January 2016 to August 2022, resulting in a total of 400,000 records. The dataset encompasses water consumption records, weather information, weekends and holidays, previous months' consumption, and the influence of the COVID-19 pandemic.We implemented and compared several machine learning models, including Linear Regression, Random Forest, Support Vector Regression (SVR), XGBoost, Artificial Neural Networks (ANN), Long Short-Term Memory (LSTM), and Gated Recurrent Units (GRU). Particle Swarm Optimization (PSO) was applied to optimize hyperparameters for all models.Our results demonstrate varying performance across subscriber types and models. For official subscribers, Random Forest achieved the highest R^2 of 0.699 with PSO optimization. For commercial subscribers, Linear Regression performed best with an R^2 of 0.730 with PSO. Residential water usage proved more challenging to predict, with XGBoost achieving the highest R^2 of 0.572 with PSO.The study identified key factors influencing water consumption, with previous months' consumption, meter diameter, and weather conditions being among the most significant predictors. The impact of the COVID-19 pandemic on consumption patterns was also observed, particularly in residential usage.This research provides valuable insights for effective water resource management in Kocaeli and similar regions, considering Turkey's high water loss rate and below-average per capita water supply. The comparative analysis of different machine learning approaches offers a comprehensive framework for selecting appropriate models for water consumption prediction in urban settings.

Keywords : mMachine learning, water consumption prediction, particle swarm optimization, COVID-19, water resource management
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