

# Leveraging Artificial Intelligence for Smart Healthcare Management: Predicting and Reducing Patient Waiting Times with Machine Learning

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## Abstract

The paper focuses on a machine-learning-based methodology for predictive modelling and simulation enhancement of hospital resource management. The proposed system is built on a multitude of machine-learning algorithms such as Random Forest Regression, XGBoost, Support Vector Regression (SVR), and Artificial Neural Networks (ANNs) to render accurate estimations of patient waiting times. Predictive modeling is then used to draw upon hospital resources that are important in consideration of the employed personnel, hospital rooms, and special equipment. To test its validity, a one-month simulation of the hospital process generated relevant statistics and other key resource utilization influencers. The performance of each model was assessed using key regression metrics, including Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and R-squared ( $R^2$ ). Preliminary experiments contrasted different machine-learning strategies, showing that the ensemble methods Random Forest and XGBoost far surpassed the traditional approaches with a mean absolute error for waiting time prediction of fewer than ten minutes. The use of deep learning models such as ANNs has also proven to yield favorable results in capturing hidden patterns in patient flow and distribution of hospital workload. The results indicate that decision support systems based on machine learning have the potential to have a tremendous impact on hospital efficiency, considering the decrease in patient waiting times and the more balanced allocation of resources. The system offered makes substantial contributions, as it provides actionable insights into demand variances and peak crowding periods that empower hospitals to make data-driven strategic decisions. Our study emphasizes the potential of artificial intelligence, simulation, and predictive analytics in health management and shows that a multi-model perspective can further enhance the allocation of resources and hospital management in practice.

**Keywords:** Machine Learning; Hospital Resource Management; Predictive Modeling; Decision Support Systems; Resource Allocation.

