

Artificial Intelligence-Driven Predictive Analytics for Improving Patient Outcomes in Healthcare

A Machine Learning Approach to Early Disease Risk Identification and Clinical Decision Support

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Abstract

The rapid growth of electronic health records and digital healthcare systems has generated vast amounts of patient data, creating opportunities for data-driven clinical decision-making. This study investigates the effectiveness of machine learning-based predictive analytics in identifying patients at risk of chronic diseases at an early stage. A retrospective dataset comprising 50,000 anonymized patient records was analyzed using supervised learning algorithms, including logistic regression, random forests, and gradient boosting techniques.

The proposed framework integrates demographic information, clinical indicators, lifestyle factors, and historical medical records to develop predictive models for disease risk assessment. Performance evaluation was conducted using accuracy, precision, recall, F1-score, and area under the receiver operating characteristic curve (AUC-ROC).

Experimental results demonstrated that the gradient boosting model achieved the highest predictive performance, with an AUC-ROC score of 0.92 and an overall accuracy of 89.4%. The findings suggest that machine learning models can significantly improve early disease detection and support healthcare professionals in making timely interventions. The study highlights the potential of predictive analytics to reduce healthcare costs, optimize resource allocation, and enhance patient outcomes while addressing challenges related to data privacy, model interpretability, and ethical considerations.

Keywords

Artificial Intelligence, Predictive Analytics, Machine Learning, Healthcare Informatics, Disease Risk Prediction, Clinical Decision Support, Electronic Health Records

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