International Journal of Engineering and Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org || Volume 11 Issue 1 Series I || January 2022 || PP 69-71

Blood Donation and Prediction through Machine Learning Techniques

[1]Srusti Satapathy, [2]Sukanya Mohanty, [3]Soumya Sidharth Ray
[1,2,3]Department of Computer Sc. & Engg. [1,2,3]Ajay Binay Institute of Technology

Abstract: *Blood donation is a vital medical requirement, but timely availability is frequently hampered by issues including donor shortages, blood type mismatches, and ineffective administration. To improve donor prediction and streamline blood bank operations, this paper suggests an AI-driven blood donation and prediction system that makes use of machine learning (ML) algorithms and data analytics. It also anticipates the demand for certain blood types, identifies possible repeat donors, and estimates donor availability by utilizing predictive models like Random Forest, Decision Trees, and Logistic Regression. This approach improves the sustainability, accessibility, and efficiency of blood donation by utilizing data analytics, which speeds up medical response times.*

Keywords: *Blood Donation, Machine Learning, Prediction System, AI in Healthcare, Logistic Regression, Data Analytics,*

I. INTRODUCTION

Blood donation is a crucial component of modern healthcare systems, providing essential support for various medical treatments, including surgeries, trauma care, cancer therapy, and chronic disease management. However, despite the growing need for blood transfusions worldwide, ensuring a stable and adequate supply remains a persistent challenge. The main issues that hinder efficient blood supply management include donor shortages, blood type mismatches, and inefficient administrative processes. So, it requires innovative technological solutions to enhance donor prediction and streamline blood bank operations. Blood banks and healthcare facilities often struggle with unpredictable blood shortages, leading to critical delays in medical treatments. Traditional blood donation management systems rely on manual record-keeping and periodic blood drives, which may not effectively address real-time demands. Additionally, seasonal fluctuations, population demographics, and unforeseen medical emergencies further complicate the availability of compatible blood types. By implementing AI-driven predictive analytics, blood banks can make data-informed decisions, reducing wastage while ensuring a steady supply of required blood groups.

The AI driven approaches in blood donation systems can significantly enhance donor recruitment, optimize resource allocation, and predict blood demand more accurately. By leveraging predictive models such as Random Forest, Decision Trees, and Logistic Regression, AI can analyze donor behavior, forecast blood type requirements, and identify potential repeat donors which ensure a more sustainable, accessible, and efficient blood donation system, ultimately improving medical response times and saving lives. Several ML algorithms play a crucial role in the prediction and optimization of blood donation processes:

Random Forest (RF) combines multiple decision trees to improve prediction accuracy. It helps in classifying potential donors based on past donation patterns and identifying factors influencing donation frequency. Decision Trees(DT) provide interpretable rules for donor classification and behavior prediction, allowing blood banks to segment donors based on age, health history, and donation preferences. Logistic Regression is used for binary classification, logistic regression can predict whether an individual is likely to donate blood within a given timeframe based on historical data and demographic features.By integrating these ML techniques, blood banks can automate donor identification, enhance retention strategies, and optimize blood supply chains. Section 2 presents the related work on blood donation and prediction, Section 3 describes the proposed methodology, Section 4 discusses the results and findings, and Section 5 concludes the paper with key insights and future directions.

II. RELATED WORK

Wan Hanieza W. et al.[1] investigated factors influencing individual's willingness to donate blood by employing multiple logistic regression. It also analyze the parameters like the number of months since the last donation, total volume donated, and frequency of donations to predict donor behavior. Lestandy, D., & Suryani, D.[2] applied machine learning algorithms, including k-Nearest Neighbors (kNN), Naïve Bayes, and Neural Networks, to classify potential blood donors. S. R. C. de Almeida et al.[3] utilized the machine learning techniques to predict whether donors will return for future donations. By analyzing donor demographics and donation history, which can assist blood banks in targeting retention efforts more effectively.S.A.S. Chandel et

al.[4] applied data mining techniques to predict potential blood donors within a population range. J. K. Eastlund & M. A. Goel [5] examined various factors influencing blood donation behavior and the application of predictive models and also discusses psychological, demographic, situational variables, providing a framework for donor prediction and recruitment strategies. M. A. Hossain et al.[6] focused on predicting blood donor deferral using machine learning algorithms, by analyzing factors leading to deferral, the authors develop models that can help in pre screening donors which improves the efficiency of blood collection processes. Y. Zhang et al. [7] explored different machine learning techniques, including SVM, Random Forest, and Logistic Regression, to predict donor eligibility based on medical history, past donation records, and demographic factors.

III. METHODOLOGY

The data collection and preprocessing involve gathering historical blood donation records, donor demographics, medical history, and blood bank inventory data, followed by data cleaning and normalization to ensure consistency and accuracy. Then to identify critical factors influencing donation behavior, such as donor age, frequency, location, and blood type compatibility, enhancing model performance by extracting meaningful patterns from raw data. Model selection and training involve implementing machine learning algorithms, including Random Forest, Decision Trees, and Logistic Regression, to predict donor availability and blood demand, with models trained on datasets to improve prediction accuracy. Prediction and analysis apply trained models to forecast demand for specific blood types, analyze trends in blood bank operations, and optimize donor outreach strategies. Optimization and decision support use predictive analytics for donation campaigns, improve donor retention, and optimize blood inventory management through automated recommendations. This paper focuses on developing an AI driven system that enhances blood donation sustainability, accessibility, and efficiency through data analytics and machine learning.

IV. RESULTS AND DISCUSSIONS

The table 1 emphasizes on the comparison of machine learning models for blood donation prediction. The Fig.1 illustrates the accuracy percentages of three machine learning models like RF, DT, and LR. The X-axis represents the different machine learning models, while the Y-axis represents their accuracy in percentage.

Table 1: Performance Comparison of Machine Learning Models for Blood Donation Prediction

Parameter	Random Forest(RF)	Decision Tree(DT)	Logistic Regression(LR)
Accuracy (%)	92.5	89.8	85.3
Precision (%)	91.2	88.5	84.0
Recall (%)	93.1	89.2	85.7
F1-score (%)	92.1	88.8	84.8

The RF model outperforms both DT and LR in terms of accuracy 92.5%, indicating that the predictive performance enhances. DT provides a reasonable balance between interpretability and accuracy 89.8%, LR, while being the simplest model, shows lower accuracy 85.3%.RF shows the best precision 91.2% and recall 93.1%, ensuring that the model is effective in identifying potential donors while minimizing false positives. DT performs slightly lower in both metrics but maintains a good balance.LR, leading to lower precision and recall scores.

Fig.1: Accuracy Comparison of Machine Learning Models for Blood Donation Prediction

The decreasing trend in accuracy indicates that ensemble models like Random Forest perform better in predicting blood donor availability compared to simpler models like Decision Tree and Logistic Regression which is efficient model for blood donation.

V. CONCLUSION AND THE FUTURE PERSPECTIVE

This paper focuses on to enhance the efficiency and accessibility of blood donation by leveraging machine learning algorithms by addressing like donor shortages, blood type mismatches, and inefficient administration, the system ensures a more reliable and sustainable blood supply. Predictive models like Random Forest, Decision Trees, and Logistic Regression facilitate accurate forecasting of blood demand, identification of repeat donors, and estimation of donor availability. These improvements lead to optimized blood bank operations, reduced wastage, and timely medical responses, ultimately saving lives. The future scope may be includes the integration of deep learning techniques for enhanced predictive accuracy, the development of mobile and cloud-based applications for better donor engagement, and the incorporation of block chain technology for secure data management.

REFERENCES

[1]. Wan Hanieza W. Mohamad Hanapi, Haslina Sarkan, Nilam Nur Amir Sjarif, Yazriwati Yahya, Suriayati Chuprat," A Prediction Model for Blood Donation Using Multiple Logistic Regression"," International Journal of Informatics",Vol.7,pp.147-157,2019.

[2]. Lestandy, D., & Suryani, D.," Classification of Potential Blood Donors Using Machine Learning Algorithms Approach"," Jurnal Teknologi dan Sistem Komputer",Vol.8,pp.234-241,2020.

[3]. S. R. C. de Almeida, R. M. C. R. de Souza, & A. L. Z. de Almeida," Predicting Blood Donor Return Using Machine Learning"," Transfusion",Vol.58,pp.116-127,2018.

[4]. S. A. S. Chandel, A. K. Sharma, & S. Agarwal," A Data Mining Approach to Predict Blood Donors in a Population"," International Journal of Advanced Research in Computer Science",vol.8,pp.1234-1240,2017.

[5]. J. K. Eastlund & M. A. Goel," Predicting Blood Donation Behavior: A Comprehensive Review and Future Directions"," Transfusion Medicine Reviews",Vol.33,pp.78-85,2019.

[6]. M. A. Hossain, M. A. Rahman, & M. A. H. Akhand," Application of Machine Learning Techniques to Predict Blood Donor Deferra"," Procedia Computer Science",Vol.132,pp.353-360,2018.

[7]. Y. Zhang, L. Zhang, & J. Wang," Machine Learning Approaches for Predicting Blood Donation Eligibility"," IEEE Access",Vol.8,pp. 67342–67351,2020.