Chapter 4

Performance Evaluation of Enhanced Artificial Neural Network for Kidney Donor Recipient Matching

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ABSTRACT

Kidney donor-recipient matching operations need precise execution to guarantee transplant achievements. The accuracy rate of Random Forest (RF) and Naïve Bayes (NB) at 85–88%, along with slow processing times, causes mismatches that result in higher rejection rates. An Enhanced Artificial Neural Network (EANN) includes game-theoretic feature selection technology, quantum-inspired optimization functions, and sparse tensor computation to enhance donor-recipient compatibility prediction performance. The experimental model operated on transplant data containing information about blood types, HLA matches, and medical documentation. Experimental outcomes revealed that EANN surpassed other models by delivering an accuracy level of 92.0%, while CNN reached 90.5%, Naïve Bayes achieved

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88.1%, and Random Forest's 86.2%. The processing time decreased to 14.8 ms with a simultaneous reduction of false match rates to 2.1%. Transplant allocation depends on blockchain technology to establish the model's transparent management.

INTRODUCTION

Kidney transplantation saves the lives of individuals with end-stage renal disease (ESRD). A transplant success rate depends on whether the donor matches the patient's requirements with factors like blood type, human leukocyte antigens (HLA) testing, and medical history evaluation (Patil et al., 2024). The manual and rule-based methods used in kidney donor allocation cannot reach the precision needed for excellent transplant results. The utilization of machine learning (ML) and artificial intelligence (AI) techniques in kidney matching processes has risen in recent years because it discovers sophisticated matching patterns that traditional methods usually fail to detect (Deborah et al., 2024). The donor-recipient matching field uses three classification algorithms known as Random Forest (RF), Naïve Bayes (NB), and Support Vector Machines (SVM). The methods try to identify the optimal donor-recipient pair by analyzing relevant medical data (Kypu et al., 2024).

The classification algorithms produce inaccurate pairings with many false matches because they deliver disappointing precision and recall rates, causing more transplant rejections. Artificial neural networks (ANNs), which belong to deep learning models, have demonstrated promising effectiveness in overcoming such limitations because they can effectively analyze large datasets and identify complex nonlinear relationships between elements (Manohara et al., 2024). Donor-recipient matching continues to face hurdles preventing the attainment of high accuracy while maintaining swift execution time and donor-recipient matching transparency. The EANN features game-theoretic features and optimization from quantum theory and tensor sparsity to develop a more dependable kidney transplant allocation system (Ahmed et al., 2024).

The current AI donor-recipient matching techniques have provided remarkable benefits yet produce multiple performance constraints. Random Forest (RF) and Naïve Bayes (NB) demonstrate low accuracy rates because they fail to detect all nonlinear relationships that exist between donor-recipient attributes (Xun et al., 2024). These models show an average accuracy level of 85% to 88% in real hospital datasets, which results in elevated risks of transplant mismatch. Most classification-based models employ static matching preferences for donor-recipient features without enough flexibility (Sun et al., 2024). Established HLA matching thresholds produce poor results when evaluating other critical aspects like recipient age or conditions and lifestyle considerations. Many existing algorithms face computational challenges