Machine Learning and Deep Learning for Pediatric and Adolescent Myopia Prediction

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Purpose: To develop and compare multiple machine learning and deep learning models for myopia prediction in children and adolescents, evaluating the performance of different algorithms in early myopia identification.

Methods: This large-scale cross-sectional study included 65,201 children and adolescents aged 3-18 years from vision screening data. Collected features included bilateral uncorrected visual acuity, corrected visual acuity, spherical power, cylindrical power, corneal curvature, as well as demographic information such as age, gender, and grade level. Nine traditional machine learning algorithms (XGBoost, Gradient Boosting, Random Forest, LightGBM, Extra Trees, Logistic Regression, K-Nearest Neighbors, Decision Tree, Naive Bayes) and two deep learning methods (FT-Transformer, TabNet) were employed for myopia prediction modeling. Data were split 70%-30% for training and testing, with model performance evaluated using accuracy, F1-score, and AUC metrics.

Results: On the test set (13,041 cases), the FT-Transformer deep learning model achieved the best performance with 85.32% accuracy, 87.29% F1-score, and 93.08% AUC, demonstrating excellent discriminative ability. XGBoost, as the best-performing traditional machine learning method, achieved 78.02% accuracy, 82.10% F1-score, and 86.98% AUC, with precision of 84.95% and recall of 79.44% for myopia identification. Feature importance analysis revealed that binocular visual acuity difference, grade level, average visual acuity, corneal astigmatism, and corneal curvature were the most important predictive factors.

Conclusions: Machine learning and deep learning models based on large-scale pediatric and adolescent screening data demonstrate excellent performance in myopia prediction, with the FT-Transformer deep learning model significantly outperforming

traditional machine learning methods. Binocular visual acuity difference, grade level, visual acuity indicators, and corneal parameters are key features for myopia prediction. These models can provide powerful technical support for early myopia screening and precision intervention in children and adolescents.

Table 1. Performance comparison of all models

Model	Accuracy	F1-score	AUC
Traditional Machine Learning Models			
XGBoost	**0.7802**	**0.8210**	0.8698
Gradient Boosting	0.7805	0.8205	0.8715
Random Forest	0.7673	0.7931	0.8700
LightGBM	0.7690	0.7952	0.8719
Extra Trees	0.7557	0.7779	0.8687
Logistic Regression	0.7614	0.7876	0.8633
K-Nearest Neighbors	0.7591	0.8116	0.8389
Decision Tree	0.7533	0.7828	0.8183
Naive Bayes	0.7226	0.7325	0.8482
Deep Learning Models			
FT-Transformer	**0.8575**	**0.8785**	**0.9307**
TabNet	0.7710	0.8042	0.8548

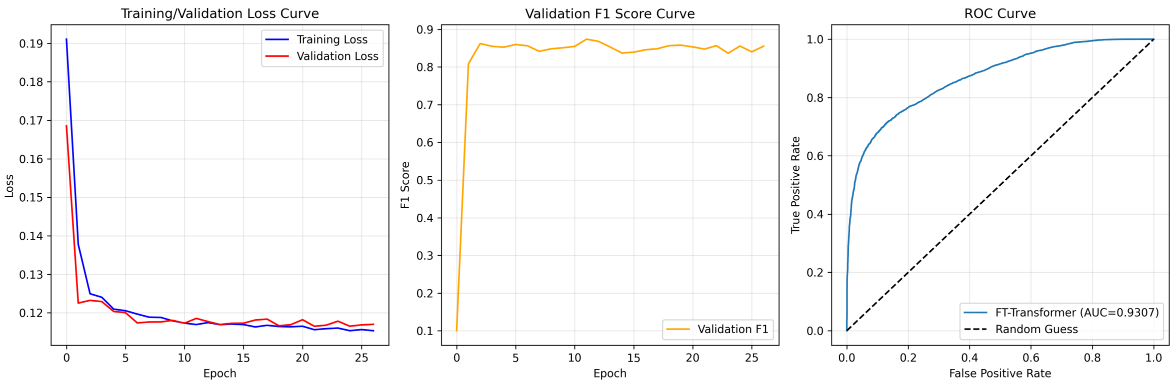

Fig. 1. Deep learning model training analysis: (a) Training and validation loss curves showing model convergence, (b) Validation F1-score progression during training, (c) ROC curve for FT-Transformer model demonstrating excellent discriminative performance