An Evaluation of Machine Learning Algorithms for Skin Disease and Cancer Detection: From Data Partitioning to Model Enhancement

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Abstract

Skin cancer is characterized by abnormal changes in skin cell structure and appearance, often leading to severe health complications. Globally, it affects approximately 25%–30% of the population, with around 200,000 new cases reported annually. This study aims to evaluate and compare the performance of 23 machine learning (ML) models in classifying skin lesions and detecting skin cancers based on dermatological image data. The dataset, sourced from the Kaggle platform, comprises seven dermatological categories: Basal Cell Carcinoma (BCC), Squamous Cell Carcinoma (SCC), Actinic Keratosis (ACK), Seborrheic Keratosis (SEK), Bowen's Disease (BOD), Melanoma (MEL), and Nevus (NEV), along with 10 predictor attributes. The classification task was divided into four schemes based on clinical grouping logic. Multi-class classification involves assigning each case to one of the seven categories. Binary classification grouped lesions as either benign (Segment B) or malignant (Segment M). Benign subgroup classification was conducted exclusively within Segment B, while malignant subgroup classification was performed only within Segment M. Each feature set was split into 90% training and 10% testing. Model performance was evaluated using accuracy as the primary metric, and statistical comparisons were made using descriptive statistics. Only two of the 23 models exceeded 50% accuracy in the multi-class scenario. Notably, in the binary classification group, four models—Fine Tree, Medium Tree, Coarse Tree, and Bagged Trees—achieved perfect accuracy on both training and testing datasets. Kernel Naïve Bayes emerged as the top performer for isolated benign and malignant classifications, with respective training/testing accuracies of 70.60%/76.22% and 67.40%/56.33%. Binary classification produced the highest overall performance across models, likely due to reduced class complexity and more precise decision boundaries. The study concludes that simplified binary classification of skin lesions can lead to highly accurate results, supporting its potential use in preliminary computer-aided diagnosis systems.

Keywords**:** *skin cancer, skin diseases, machine learning, computer-aided diagnosis, classification models*