Enhancing Skin Cancer Detection Using Curriculum Learning In Ensemble Deep Learning Context

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Abstract

Accurate classification of skin lesions, particularly for melanoma detection, remains a critical challenge in medical image analysis. Leveraging recent advances in deep learning, this paper investigates the use of curriculum learning in ensemble deep learning context for melanoma classification. To validate the proposition, three primary strategies are compared: transfer learning of CNNs using VGG16, ResNet50, and EfficientNetB0 models; ensemble learning techniques such as bagging; and curriculum learning that progressively guides training in increasing order of complexity. Experiments conducted on the ISIC 2019 and 2020 dermoscopic image datasets demonstrate that curriculum learning applied to EfficientNetB0 achieves superior classification performance, reaching an F1- score of 90.77%, outperforming conventional fine-tuning and ensemble approaches. These results underscore the potential of integrating curriculum learning in ensemble learning context with state-of-the-art CNN architectures to improve the robustness and accuracy of automated melanoma diagnosis.

Keywords

Skin Lesions, Melanoma Detection, Deep Transfer Learning, Ensemble Deep Learning, Medical Image Analysis, Medical Diagnosis, Curriculum Learning

1. Introduction

The accurate and early diagnosis of skin cancer, particularly melanoma, is a critical public health challenge due to its aggressive nature and potential for metastasis if undetected. Traditional manual interpretation of dermatological images by clinicians is a complex, time-consuming task prone to inter-observer variability, misdiagnosis, or delayed treatment [1]. This inherent difficulty arises from the subtle visual similarities between benign and malignant lesions, significant intra-class variability, and the presence of confounding image artifacts. Consequently, there is an urgent need for robust, automated diagnostic tools to augment clinical decision-making.

Artificial Intelligence (AI), and specifically deep learning (DL), has emerged as a transformative force in medical imaging, offering unprecedented opportunities to enhance diagnostic efficiency and accuracy [2]. Deep Convolutional Neural Networks (CNNs) have demonstrated state-of-the-art performance across numerous medical image analysis tasks, including detection, segmentation, and classification [3]. Their remarkable ability to automatically learn hierarchical, discriminative features directly from raw image data spares the labor-intensive process of manual feature engineering, making them particularly well-suited for intricate diagnostic problems like skin lesion classification [4]. Furthermore, transfer learning (TL), which involves fine-tuning or reusing features from models pre-trained on large-scale datasets such as ImageNet, has proven highly effective in medical contexts where annotated datasets are typically scarce [5]. Architectures like VGG16, ResNet50, InceptionV3, EfficientNetB0, and Xception have been widely adopted through TL to achieve commendable performance in dermatological applications.

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