Automated and Interpretable Glaucoma Classification Using Deep Learning and Optical Coherence Tomography Images

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Purpose

Glaucoma is the leading cause of irreversible blindness and represents a significant public health challenge worldwide. Early detection is crucial for effective management and preservation of visual function. In this study, we exploit the capabilities of a cutting-edge deep learning algorithm, ConvNeXt, to automate glaucoma classification using optical coherence tomography (OCT) images.

Methods

The model is trained and tested on a set of macular OCT scans from the UK Biobank dataset, which includes 448 glaucomatous and 5,619 healthy eyes. Utilizing transfer learning and fine-tuning techniques, we enhance the model's performance in detecting glaucoma. To gain insights into the learned representations, we employ class activation mapping, revealing the regions of interest that influence the model's predictions and thereby facilitating interpretability. The model's efficacy is evaluated using multiple quantitative metrics, such as accuracy, sensitivity, specificity, and the area under the receiver operating characteristic curve (AUC).

Results

Through 10-fold cross-validation, the model achieved an average AUC of 0.963 using ConvNeXt as the deep learning backbone. Notably, even when other state-of-the-art models were employed as the machine learning backbone, the model consistently achieved an AUC around 0.960, demonstrating the robustness of the algorithm in facilitating precise glaucoma detection.

Conclusions

Our results suggest that raw macular OCT scans can be directly used for glaucoma classification without requiring prior segmentation. These findings highlight the considerable potential of machine learning algorithms, particularly deep learning models, in automating the detection of glaucoma.