Comparative Analysis of Machine Learning Algorithms for Lesion Segmentation in Eye Fundus Images

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Introduction

- Uveal melanoma is a rare condition that can impair vision and even result in death.
- Machine learning techniques have shown promise in enhancing the precision and speed of diagnosis of some cancers.
- Similar applications of machine learning may help in identifying and diagnosing uveal melanoma, reducing symptoms severity, improving treatment outcomes, and increasing chance of survival.

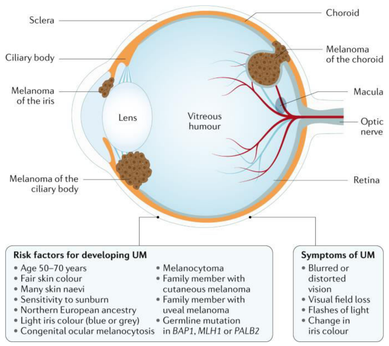

Fig 1: Uveal Melanoma

Objective

This study strives to create a segmentation module with exceptional accuracy that can extract precise measurements to support ophthalmologists and oncologists in assessing patient risk factors for uveal melanoma. By evaluating and comparing the effectiveness of multiple CNN-based segmentation models, this research serves as a crucial initial step in enhancing the accuracy of patient assessments. Ultimately, the goal is to provide personalized treatment recommendations based on the obtained measurements.

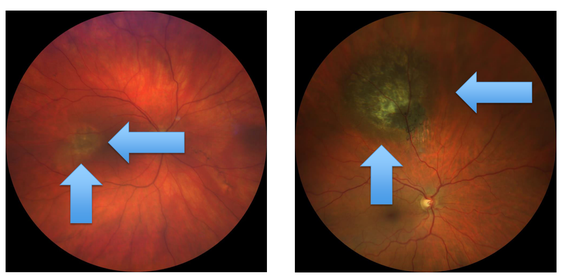

Fig 2: Eye fundus image with detected lesion

Methods

- **Preprocessing** the images to enhance features. Here we use Python as our main programing language and libraries like Pandas, NumPy, TensorFlow or ScikitLearn.
- **Implementation** of various machine learning methods, including convolutional neural networks (CNNs) and its combination with generative adversarial network (GAN) to segment the images and find the lesions.
- **Comparing** the performance of the different machine learning methods and identifying the most accurate and efficient algorithm/method.
- **Validation** the performance of the selected algorithm or method on a separate test set of images and actual validation of ophthalmology experts.

Dataset

- **Fundus Image Dataset** including healthy eyes and eyes with lesions which might or might not be cancerous.
- **Ground Truth Mask Dataset** which is produced based on the ophthalmology knowledge.

Dataset Specifications	Number	Size	Kind	Contain Lesions
Fundus Images	684	3900*3900	RGB	50%
Masks (Ground Truth)	342	3900*3900	Black & White	100%

Table 1: Dataset Specifications

Funding

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Results

The results are yet to be determined but so far, the Residual Attention U-net has the best results comparing to U-net and Attention U-net. (Table2)

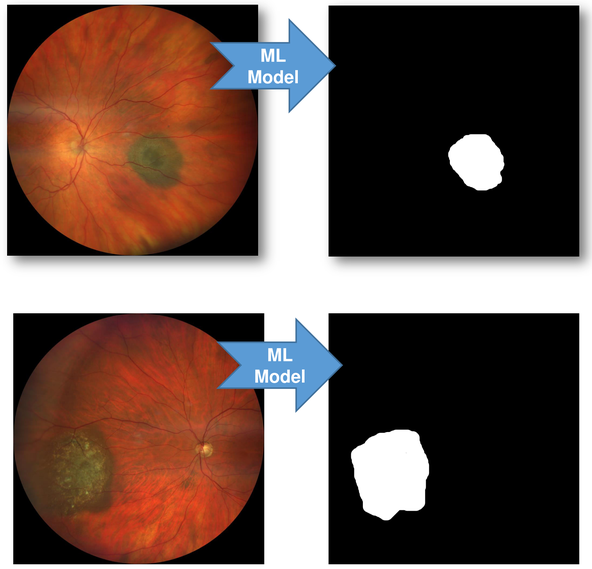

Fig 3: Eye fundus images (Left) and its extracted lesion images (Right)

Algorithm	U-net	Attention U-net	Residual attention U-net	Eye fundus specific segmentation algorithm
Loss	0.028	0.025	0.024	TBD*
IOU	TBD*	TBD*	TBD*	TBD*
Accuracy	TBD*	TBD*	TBD*	TBD*

Table 2: Segmentation model comparison
* TBD: to be demonstrated

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Conclusion

The aim of this study is to develop a highly accurate segmentation module that can extract precise measures to aid ophthalmologists and oncologists in assessing patient uveal melanoma risk factors and providing personalized treatment recommendations based on these measures. The study involves evaluating and comparing the performance of various CNN-based segmentation models and represents a crucial first step towards improving patient assessment accuracy.

In this research we aim to compare different ML algorithms in order to find the one that works better for segmentation of the eye fundus image and highlight the lesions more accurately.

Future works

- Develop a precise measurement module that can accurately assess the risk and stage of uveal melanoma based on the segmented mask.
- Augmenting the measurements obtained from this module with demographic information and data extracted from physicians and pathology reports using NLP techniques. This can help identify different risk factors and create patient profiles to provide personalized treatment recommendations for uveal melanoma.

References

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