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# Deep Learning for Efficient Screening for Retinal Disease from Large OCT Datasets by Knowledge-based Distillation


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## Purpose

- **Assessing large number of Optical Coherence Tomographies (OCTs)** for screening purposes or retrospective data analysis is **time-consuming and costly**;
- **Artificial Intelligence can help** to automate these tasks.
- However, **developing machine learning models for detecting every possible disease is not feasible** as it requires an immense amount of time and resources;
- Generic **Deep Neural Networks (DNNs) that detect anomalies** by learning what are the normal cases is a more viable approach.

## Methods

- The DNN infers an **anomaly score map** for each B-scan;
- Reverse Teacher-Student (T-S) **knowledge distillation** is used[1]:

**The Student does not properly represent anomalous B-scan regions**, leading to **differences with the intermediary features from the Teacher**

- T is pre-trained on ImageNet for **natural image classification** and is frozen during training and inference;
- S has **random weights** and approx. half of T's parameters.

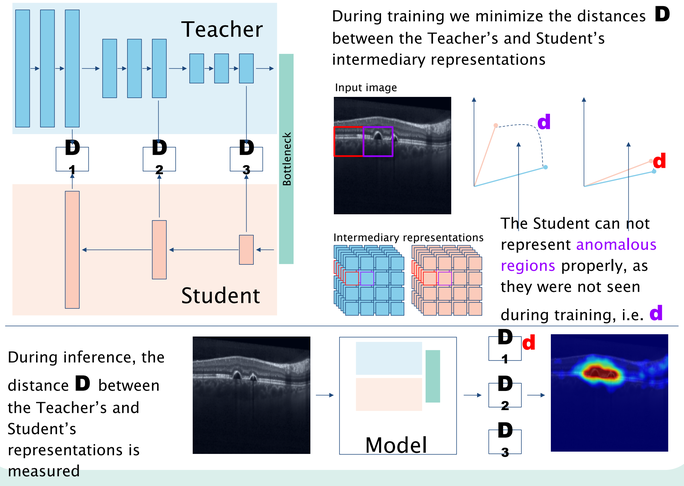
During training:
- the model only has access to **healthy B-scan**s;
- S is trained to **replicate the intermediary representations** of T by minimizing their distance *d*.

At inference:
- the **differences** *d* between the features of T and S **are measured for all B-scans**, leading to an **anomaly map**;
- A volume-wise score is obtained as the maximum anomaly score for all B-scans of an OCT.

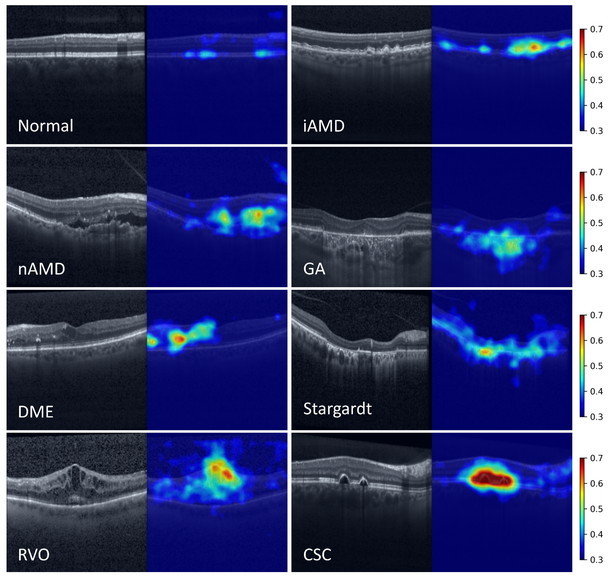
## Data

- Heidelberg Spectralis fovea-centered OCT scans were used;
- The model is trained with 5191 normal B-scans from 278 eyes;
- The model is **tested in 118 normal eyes and 2850 eyes with different pathologies.**

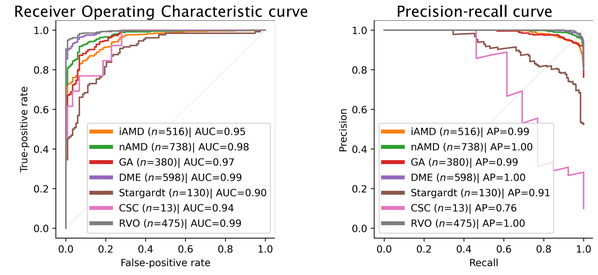
## Reverse knowledge distillation




## Explanation with anomaly detection maps




## Results




- The average volume-wise anomaly detection area under the ROC curve was **0.96±0.03**;
- The **anomaly profile** suggests higher pathology presence near the fovea;

## Conclusions

- DNNs are efficiently **capable of detecting anomalous retinal OCT volumes** by learning exclusively from normal cases;
- Together with an **interpretable explanation** of the decision, these systems can **facilitate large scale patient screening** from real-world datasets for therapeutic management and trial selection.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**References**


[1] Deng, Hanqiu *et al.* 2022. Anomaly Detection via Reverse Distillation From One-Class Embedding. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR).


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