Deep Learning for eye disease detection

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Abstract

Detecting eye diseases at an early stage is vital for effective treatment and prevention of vision loss. Image based deep learning algorithms have emerged as a promising approach to automate this process, providing accurate and efficient diagnoses. In this study, we propose some deep learning model for the detection of various eye diseases using image as input. We explore different deep learning architectures, particularly Convolutional Neural Networks (CNNs), ResNest model, and investigate their suitability for eye disease detection task. At the end of this study, we note that Restnet model, a pretrainning model has higher scores than the CNN model in both the training and test phases. This suggests that the Restnet model is performing better overall based on the provided scores.

1 introduction

Artificiel Intelligent have revolutionized the field of medical diagnostics, particularly detecting diagnosing eye diseases. The human eye is a complex organ that can be susceptible to various diseases and conditions, many of which can lead to serious vision impairment or even blindness if not detected and treated early. Traditional methods of diagnosing eye disease often rely on the manual interpretation of medical images by trained specialists, which can be time consuming and prone to human error. However, with the advent of deep learning techniques, the process of detecting eye disease has become more accurate, efficient and accessible. Deep learning algorithms, a subset of machine learning, are designed to automatically learn and extract intricate patterns and features from large datasets. Convolutional Neural Networks (CNNs), a popular form of deep learning architecture, have shown remarkable success in analyzing medical images, including those of the eye.In this project, we used the convolutional neural network method as well as computer vision methods such as Resnet to detect the type of eye disease from the data that we collect from goolge, kaggle.

2 Related work

In recent years, the application of deep learning models, particularly Convolutional Neural Networks (CNNs), and advanced computer vision architectures,

such as ResNet, have shown significant promise in the field of eye disease detection. This section provides an overview of the relevant research conducted in the domain of using these models for early detection and diagnosis of various eye diseases.

Before establishing the different processes involved in obtaining a high performance model, it is important to define the different diseases and the consequences these diseases have on long-term vision.

2.0.1 Glaucoma

Glaucoma is a group of eye conditions that damage the optic nerve. The optic nerve sends visual information from your eye to your brain and is vital for good vision. Damage to the optic nerve is often related to high pressure in your eye. But glaucoma can happen even with normal eye pressure.mayoclinic

2.0.2 Cataracs

A cataract is a cloudy area in the lens of your eye (the clear part of the eye that helps to focus light). National Eye Institute

2.0.3 Bulging Eyes

Bulging or protruding of one or both eyes is called proptosis or exophthalmos. Exophthalmos is usually used when describing bulging eyes caused by Graves disease, a disorder causing overactivity of the thyroid gland (hyperthyroidism). Bulging eyes are not the same as prominent eyes. Some disorders that may change the appearance of the face and eyes but that do not cause true eye bulging include Cushing disease and severe obesity.MSE MANUAL

2.0.4 Uveitis

Uveitis is inflammation inside your eye. Inflammation usually happens when your immune system is fighting an infection. Sometimes uveitis means your immune system is fighting an eye infection — but it can also happen when your immune system attacks healthy tissue in your eyes. Uveitis can cause problems like pain, redness, and vision loss.Eye Disease Instituts

2.0.5 crossed eyes

Crossed eyes, or strabismus, is a condition in which both eyes do not look at the same place at the same time. It usually occurs in people who have poor eye muscle control or are very farsighted.American Optometric Association

2.1 Image data processing

Image data processing is an important step in the process of building high performance models. In this project, we used torchvision.transforms module. All

the transformation can be chained together using Compose. We defines a series of data augmentation and preprocessing transformations that can be applied to images. Data augmentation is a technique used to artificially increase the size of a training dataset by applying various transformations to the original images, thereby introducing diversity and robustness into the training process. These transformations help the deep learning model generalize better to new, unseen data and improve its performance.

- first we Resizes the input image to a fixed size of 224x224 pixels. This allow to make sure that all the images are the same size before feeding them into the model.
- Horizontally flips the image with a certain probability. This helps the model learn features from different orientations and improves its ability to recognize objects from multiple viewpoints.
- Converts the image into a PyTorch tensor. Deep learning models typically work with tensors as inputs, so this step is essential to process the image further.
- Normalizes the tensor by subtracting the mean values [0.485, 0.456, 0.406] and dividing by the standard deviation values [0.229, 0.224, 0.225]. Normalization helps stabilize the training process and improves convergence of the model during training.

As mentioned in the introduction, the images that we use for this project come from different sources, in particular kaggle and google, which we have put into folders for each disease. Each folder represents a specific disease.

2.2 Convolutionnal Neural Network for eyes diseases detection

Convolutional Neural Networks (CNN) have shown remarkable success in various computer vision tasks, including medical image analysis such as detecting eye diseases. Here's a general outline of the process for using CNN for eye disease detection. But before this let have a quit review on the model. Deep learning is a machine learning technique used to build artificial intelligence (AI) systems.

A CNN, or Convolutional Neural Network, is a deep learning model specifically designed for processing and analyzing visual data, such as images and videos. It's a type of neural network architecture that we can use for the tasks like image classification, object detection, image segmentation etc. [3]

The architecture of a convolutional network typically consists of four types of layers: convolution, pooling, activation, and fully connected.

- **Convolutional Layer** : This is the core building block of a CNN. It involves applying a set of learnable filters (also known as kernels) to an input image. Each filter detects a specific feature or pattern, such as edges, textures, or shapes. The convolution operation helps extract relevant features from the input.

- **Pooling Layer** : Also known as subsampling or downsampling, this layer reduces the spatial dimensions of the feature maps while retaining the most important information. Max pooling and average pooling are common techniques used for this purpose. Pooling helps to reduce computational complexity and increase the network's ability to generalize.
- **Activation Function** :An activation function introduces non-linearity to the model, enabling it to learn complex relationships in the data.
- **Fully Connected Layer** : These layers are typical neural network layers where each neuron is connected to every neuron in the previous layer.this step allow to make final prediction

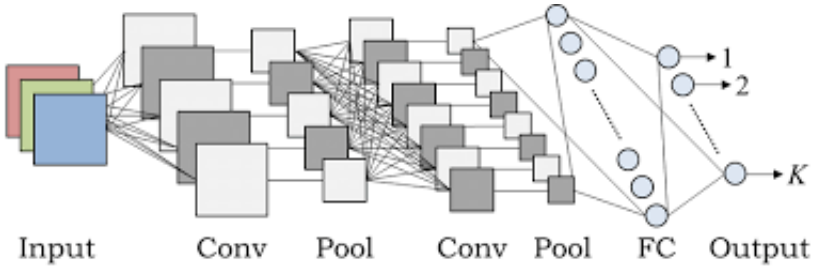

Figure 1: cnn architecture

Image source After training our model, in the following results we can observe that the training scores keep improving while the test scores start to plateau or even decrease. This could indicate overfitting, where the model becomes too specialized to the training data and performs poorly on new data.

even if we use regularization methods such as dropout, which consists in randomly deactivating certain neurons according to a given probability, or l2 regularization, a technique that used to prevent overfitting by adding a penalty term to the loss function of a model. The penalty term is based on the magnitude of the weights in the model. The aim was to obtain a high-performance model, but we can see that the training time is long and the model doesn't give a very good accurency.

Since we don't have enought data to trainning our model and we need to get a good accurency to make sure that our model get a good accurate. For this we can use Transfer Learning.The aims of this approch (transfer Learning) is to use the knowledge already acquired to solve a completely new, but related problem. In other words, the technique is to transfer the notions learned on a source dataset to be more efficient in the processing of a new target dataset. So we don't need to train the model from scratch , we use a pre trainning model which are usually trained on massive datasets that are a standard benchmark in the computer vision frontier. The weights obtained from the models can be reused in other computer vision tasks. neptune.Ai The advantage of a pre-trained models is that they are generic enough for use in other real-world applications.

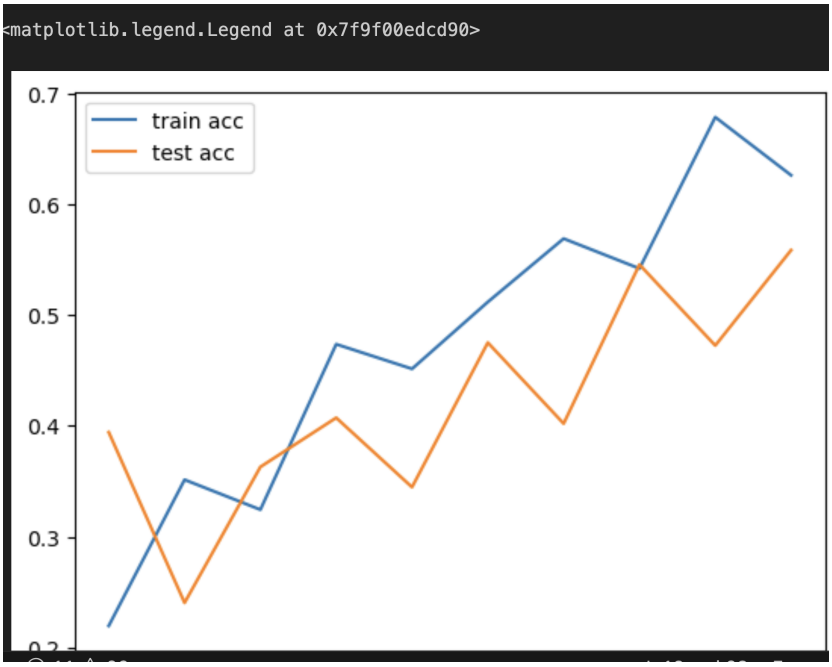

Figure 2: CNN Score

2.2.1 ResNest

ResNet, or Residual Network, is a deep learning model used for computer vision applications. It is a Convolutional Neural Network (CNN) architecture designed to support hundreds or thousands of convolutional layers. It is an innovative neural network created for image classification.

ResNet (Residual Network) is a deep neural network architecture that introduced the concept of residual blocks, which helps address the vanishing gradient problem in training very deep networks. [2]. This method ignore some connections and make double or triple layer jumps that contain non-linearities (ReLU). as we see in the follows image ovhcloud

There are different variants of resnet model

- ResNet-18: This is the smallest ResNet model, with 18 convolutional layers.
- ResNet-34: This is a slightly larger ResNet model, with 34 convolutional layers.
- ResNet-50: This is a popular ResNet model, with 50 convolutional layers.
- ResNet-101: This is a larger ResNet model, with 101 convolutional layers.
- ResNet-152: This is the largest ResNet model, with 152 convolutional layers.

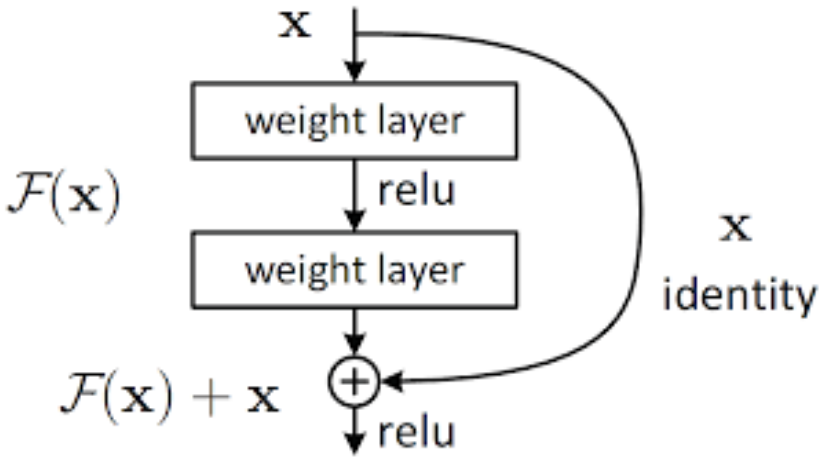

Figure 3: Resnet architecture

The choice of which ResNet variant to use depends on the specific task and the amount of computational resources available. In this project , we iuse resnet 50

From this this result, we you observe a significant improvement in accuracy on trainning score. This accuracy keeps increasing and reaches quite high values (around 0.97) towards the end of training. we make the same remark for the test score even this score is relatively low at the beginning with a score of 0.53 .There's some fluctuation in the testing accuracy, which is expected as the model continues to adjust its parameters during training

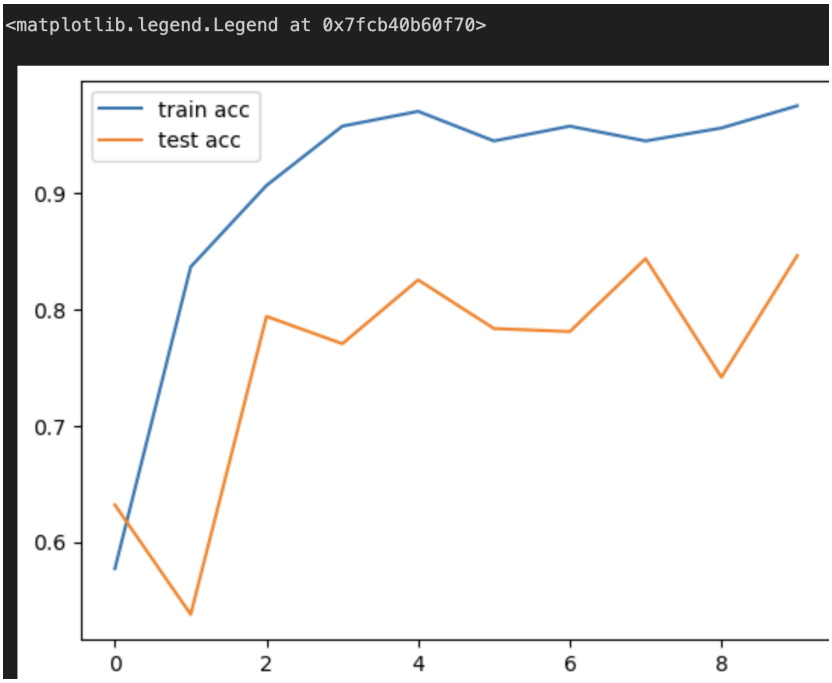

Figure 4: Resnet score

2.3 Result

Modele	Restnet	CNN
Train score	0.97	0.76
Test score	0.81	0.71

From the table, you can observe :

- **Training** For the "Restnet" model, the training score is 0.95. For the "CNN" model, the training score is 0.76. The training score reflects how well the models fit the training data. A higher training score suggests that the model is better at capturing patterns and features in the training dataset. In this case, the "Restnet" model has a higher training score, indicating that it is performing better on the training data compared to the "CNN" model.

- **Test Score:** For the "Restnet" model, the test score is 0.81. For the "CNN" model, the test score is 0.71. The test score indicates how well the models generalize to new, unseen data. A higher test score implies that the model is better at making accurate predictions on data it hasn't seen before. Here, the "Restnet" model also has a higher test score compared to the "CNN" model, suggesting that it's performing better on new data as well.

In summary, based on the provided scores, the "Restnet" model outperforms the "CNN" model in both training and test phases. It's important to note that while these scores give an indication of model performance, additional analysis and considerations are needed to fully understand the models' capabilities, such as potential overfitting, dataset characteristics, and the specific problem being addressed.

3 Conclusion

CNNs are a type of deep learning model that are particularly well-suited for image recognition tasks. They work by learning to identify patterns in images, and they can be used to classify images into different categories.

ResNet is a type of CNN architecture that has been shown to be very effective for image classification tasks. It is particularly good at learning long-range dependencies in images, which makes it well-suited for tasks such as object detection and semantic segmentation. From this study, we notice that the ResNet model exhibits superior performance in the task of eye disease detection using deep learning, as indicated by higher training and test scores compared to the CNN model. This suggests that the ResNet architecture has a better ability to generalize and capture complex features within the medical imaging data, making it a more promising candidate for practical medical applications. However, comprehensive evaluation and validation are essential before deploying any model for real-world medical diagnosis.

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