Automated Diagnostic Classification of Pediatric MR Angiography

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Introduction

Cerebrovascular disorders are an important cause of mortality and long-term morbidity in the pediatric population. Accurate diagnosis is essential to selecting appropriate treatment. Assessment of suspected cerebrovascular disorders requires distinguishing between normal Magnetic Resonance Angiogram (MRA) and abnormal MRA. However, accurate pediatric MRA interpretation requires years of training.

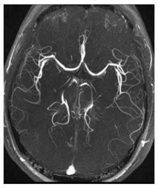


Figure 1. MRA Scan

Problem Statement

Deep Learning to develop clinical decision support tools that provide real-time diagnostic support and guide clinical decision-making. Use it to classify cerebral vessels and segmenting cerebrovascular structures. No studies yet have broached automated diagnostic classification of pediatric MRA.

Dataset & Features

Dataset of 278 patients with pediatric MRA images from 2011 to 2017, split into 227 normal cases and 51 abnormal cases, specifically Moyamoya disease. The number of cross sections in the MRA scans varies across patients (248 or 256). The database also includes images from other types of structural scanners of the brain, apart from MRA images.

The image appears black-and-white but consists of three color channels. The dimensions of each image is (512, 512). We preprocessed the data by compressing the images into either (64, 64) or (256, 256) images, and further flattened them for our logistic regression model.

Deep Learning Approach

Because convolutional neural networks (CNNs) are conventionally successful in image classification, we tried testing CNNs on our dataset in addition to our baseline logistic regression model. Because of our relatively underpowered dataset, we decided to bring in pretrained models through ResNet18 and ResNet50, which were trained on ImageNet.

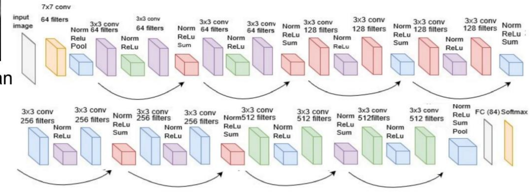


Figure 2. Architecture of the ResNet18 model

Conclusions

We can see there is much promise in the pursuit of automated diagnostic classification of blood vessel abnormalities in MRA scans. Much as we anticipated, we saw an improvement in the performance of our model when we could augment the training dataset, whether by including non-MRA scans or using a pretrained model.

Future Work

This study is limited by its retrospective nature and modest sample size. Future work will include a prospective study with a heterogeneous patient population to conduct further validation of this model for its integration into clinical practice.

We are also looking to develop a model to label abnormal MRA dataset for five of the most important disease classes. Apply 2D and 3D deep learning architectures (ResNet and DenseNet) to conduct multi-label binary classification of desired outcomes.

Results & Discussion

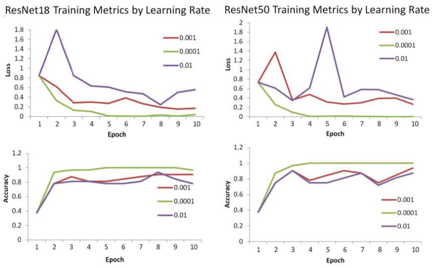
Table 1. Comparative Model Performance

	Train Acc	Dev/Test Acc
LR (all images)	0.98431	0.91765
LR (only MRA images)	1	0.9
CS230 Torch Vision Example	0.906	0.827
ResNet18	0.969	1
ResNet50	1	1

Logistic regression performed surprisingly well as a baseline. We saw that adding in all the images in the database to expand the training set actually improved our logistic regression model, supporting the idea that a pretrained network would improve our model. We can also clearly see that the ResNet models outperformed any other. Below, we tried tuning the learning rate to compare performance among hyperparameters as well as across models.

We had a train-dev-test split to train, tune, and test our model. We can see that the lowest learning rate resulted in the highest performance, as expected. We also see that ResNet18 seems to generally outperform ResNet50 in this binary classification task.

Figure 3. ResNet Training Results



Acknowledgements

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