Classification of MRI imaging of ASD using deep learning methods

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24-2-R-8

Motivation

Autism spectrum disorder (ASD) is a neurodevelopmental condition affecting social communication and behavior, but its diagnosis remains complex. There is no clear biological marker, with only 10% to 38% of cases having a known genetic cause. Diagnosis relies on subjective behavioral criteria, making it difficult to establish objective measures. Additionally, ASD presents with wide symptom variability, further complicating identification.

The Dataset

In this project, we investigated ASD patients' brain imaging data from a worldwide multi-site database known as ABIDE (the Autism Brain Imaging Data Exchange) to improve ASD diagnosis accuracy and reliability.

Fig 1. MRI image of a brain without ASD

Fig 2. Fig 1. MRI image of a brain with ASD

Result

We built a system with over 90% accuracy in detecting autism spectrum disorders (ASD). Using MRI scans from the ABIDE (Autism Brain Imaging Data Exchange) multi-site database, we trained a Convolutional Neural Network (CNN) to improve the accuracy and reliability of ASD diagnosis.
Our CNN model was based on the Inception V3 architecture, and we evaluated its performance with respect to parameters such as learning rate, epochs, and batch size. By utilizing transfer learning, we were able to fine-tune the model effectively.

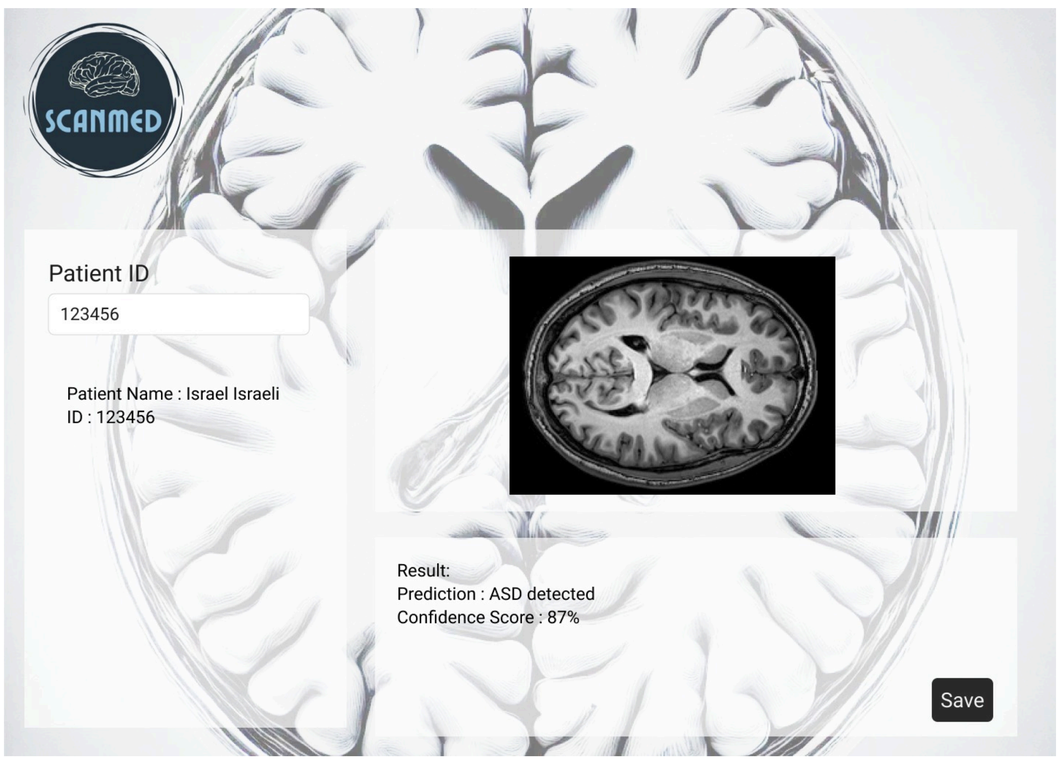

Fig 3: The system after entering patient details and NII file.

Methodology

Inception V3 Algorithm

Inception V3, an efficient CNN, was chosen for its strong feature extraction and suitability for image classification.

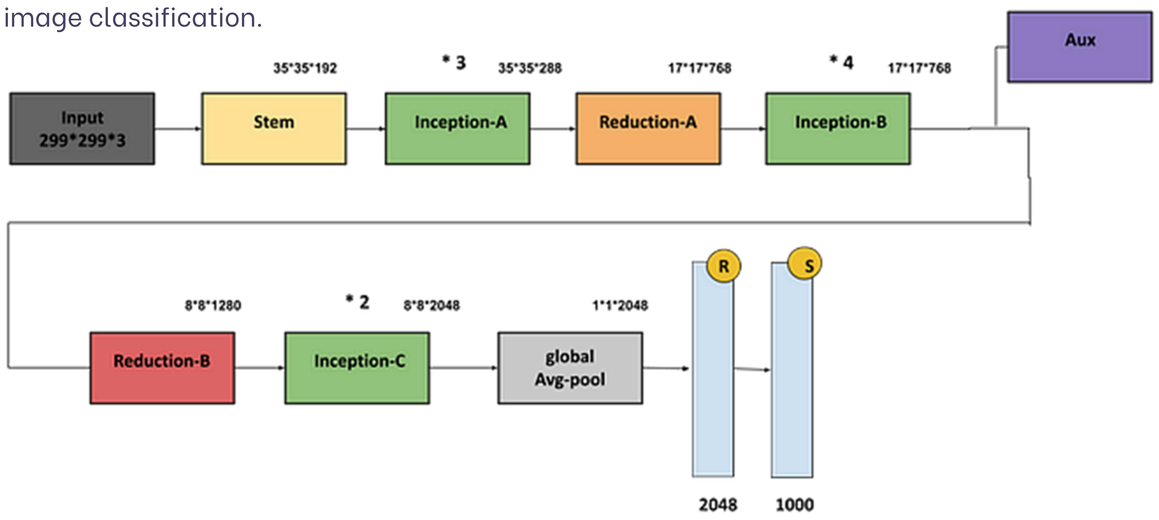

Fig 5. Inception V3 architecture.

Stem: Convolutional and pooling layers for basic feature extraction.
Inception-A: Parallel convolutions (1×1, 3×3, 5×5) for multi-scale features.
Reduction-A: Downsampling with convolutions and Max Pooling.
Inception-B: Larger filters for capturing complex patterns.
Reduction-B: Aggressive downsampling with Max Pooling.
Inception-C: Wider and deeper filters for high-level features.
Global Max Pooling: Reduces dimensions by keeping the most significant values.
Auxiliary Classifier: Helps mitigate gradient vanishing via intermediate classification.
Fully Connected Layers: Final layers for classification.
Softmax: Outputs class probabilities.

Transfer Learning

Transfer learning was used to improve model performance by leveraging knowledge from a pre-trained network. The model was initially trained on a large, diverse dataset and then fine-tuned on the ABIDE dataset for the specific task of classifying ASD in adults.

The Optimization

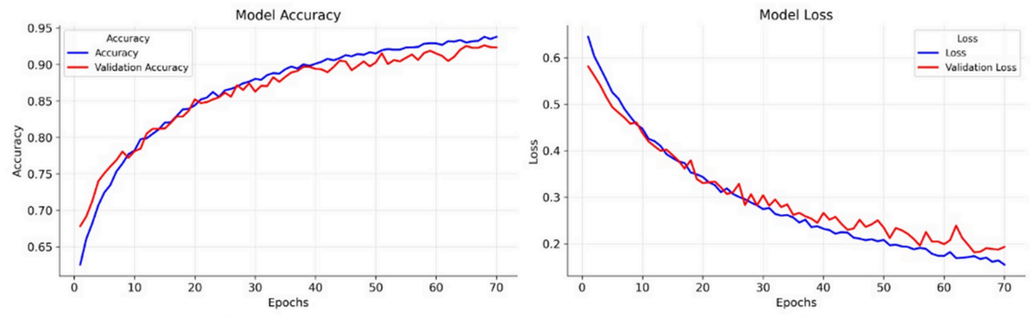

Fig 4. Comparison of the graphs we got from training the Inception V3 model.

F1-Score	Validation Accuracy	Train Accuracy	Epochs	Learning Rate	Optimizer	Dataset
0.75	90%	90.27%	40	0.0001	Adam	ABIDE
0.832	91.21%	92.32%	50	0.0001	Adam	ABIDE
0.88	92.59%	94.56%	70	0.0001	Adam	ABIDE

Table 1. Performance of Inception V3 with various configurations.

Conclusion

We built a system with over 90% accuracy in detecting autism spectrum disorders (ASD). Using MRI scans from the ABIDE (Autism Brain Imaging Data Exchange) multi-site database, we trained a Convolutional Neural Network (CNN) to improve the accuracy and reliability of ASD diagnosis.
Our CNN model was based on the Inception V3 architecture, and we evaluated its performance with respect to parameters such as learning rate, epochs, and batch size. By utilizing transfer learning, we were able to fine-tune the model effectively.

Referance

- Rethinking the Inception Architecture for Computer Vision Christian Szegedy Google Inc,Vincent Vanhoucke, Sergey Ioffe, Jonathon Shlens
- ABIDE data set https://fcon_1000.projects.nitrc.org/indi/abide/
- Autism Spectrum Disorder Classification Using Deep Learning, Abdulrazak Yahya Saleh,Lim Huey Chern