ASDNet: Classification of autism spectrum disorder from MRI Images using recurrent neural networks

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Introduction

Background

- Accurate and early diagnosis of ASD improves the quality of life of individuals with ASD and their families (Elder et al., 2017)
- Machine learning and computational algorithms show promise in helping diagnose diseases such as Alzheimer's disease from neuroimaging datasets (Yang et al., 2018)
- Artificial neural networks learn to perform tasks through presentation of labeled examples and application of learning rules that change the network's structure

Significance

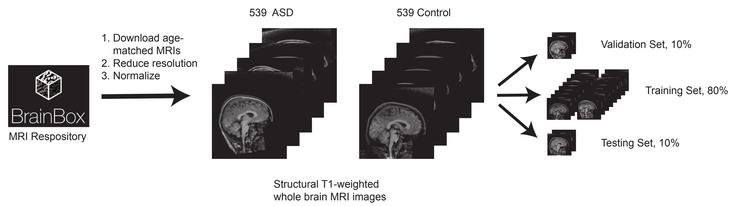
Implementation of neural networks can potentially change the way ASD is diagnosed, leading to faster interventions and better outcomes.

Research Question

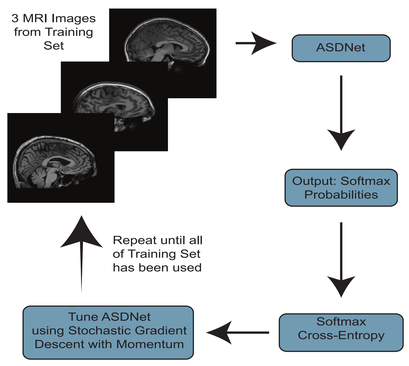
How can neural networks be used to classify ASD and what features are important in performing this classification?

Methods

A. Download, Preprocess, and Split MRI Images



B. One Training Epoch

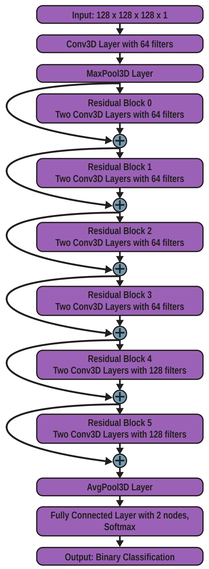


C. Training Parameters

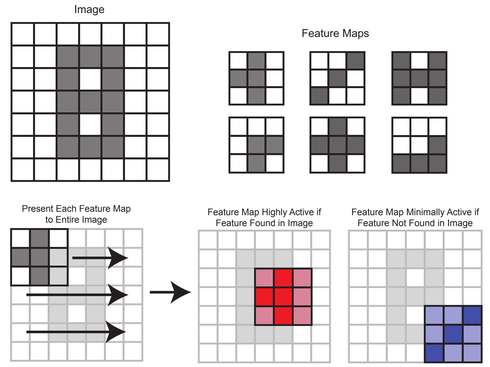
Number of Training	150
Initial Learning Rate	1e-4
Number of LR Decays	3
Momentum	0.9
Batch Size	3
Batch Normalization Epsilon	1e-5
Batch Normalization Momentum	0.997
Number of GPUs Used	4

Methods

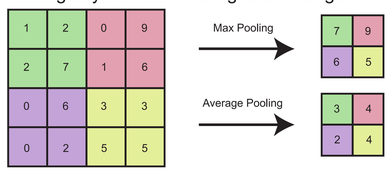
D. ASDNet Architecture



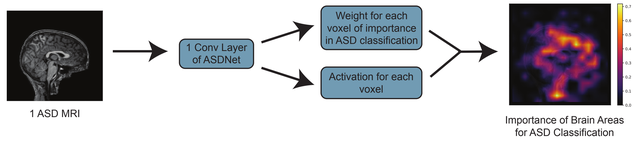
E. Convolutional Layers and Feature Maps



F. Pooling Layers: Max Pooling and Average Pooling

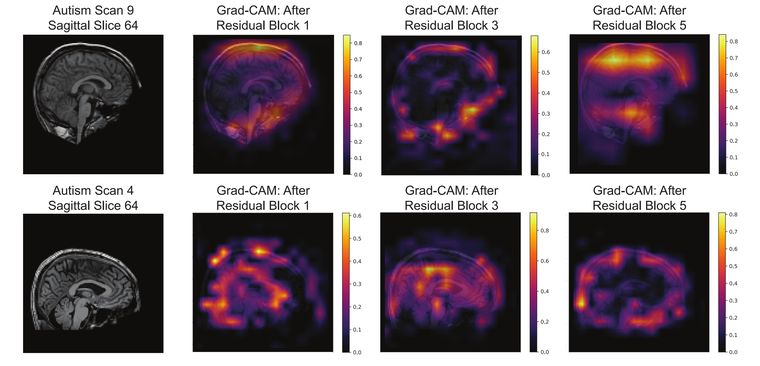


G. Visualization with 3D Gradient-Weighted Class Activation Mapping (3D-Grad-CAM)



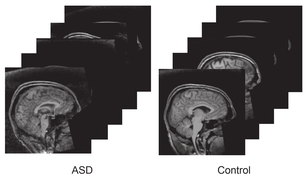
Results: Visualization of Residual Blocks

C. 3D-Grad-CAM



Results: Binary Classification

A. Binary Classification Testing Accuracy: 0.677 ± 0.041



B. Classification Validation Accuracy During Training

Conclusions and Summary

1. ASDNet focuses on the total brain volume in classifying ASD, evidenced by the high level of attention paid to the borders of the brain, which is consistent with previous MRI studies in individuals with ASD (Chen et al. 2011)
2. Behavioral assessments currently used for diagnosis of ASD can have inter-observer reliability as low as 55.83% (Guercio et al. 2015), lower than the current ASDNet classification accuracy of 67.7%
3. Combining neural network classification with current behavioral assessments could dramatically increase diagnostic reliability and reduce subjectivity
4. ASDNet may be a viable way to improve current behavioral assessments, assess age groups too young to be assessed with behavioral exams, and lower healthcare costs by making earlier and more accurate diagnoses

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References

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Elder, J. H., Kreider, C. M., Brasher, S. N., & Ansell, M. (2017). Clinical impact of early diagnosis of autism on the prognosis and parent-child relationships.

Guercio, J. M., & Hahs, A. D. (2015). Applied Behavior Analysis and the Autism Diagnostic Observation Schedule (ADOS): a Symbiotic Relationship for Advancements in Services for Individuals with Autism vSpectrum Disorders (ASDs).

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