Deep Residual Nets for Improved Alzheimer's Diease Diagnosis

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Introduction

- Advancements in deep learning algorithms have improved the fields of computer vision and biomedical image analysis.
- Alzheimer's disease diagnosis can benefit from modern computer vision techniques that can detect imperceptible alterations in morphology via brain MRIs.
- The dearth of curated medical data, however, makes it difficult to build algorithms with clinical relevance.
- Techniques for overcoming data limitations, such as transfer learning and data augmentation may prove invaluable to the efficacy of image-based clinical decision support.

Question 1

Does a pretrained residual neural network transfer to the MRI domain to improve prediction in Alzheimer's diagnosis?

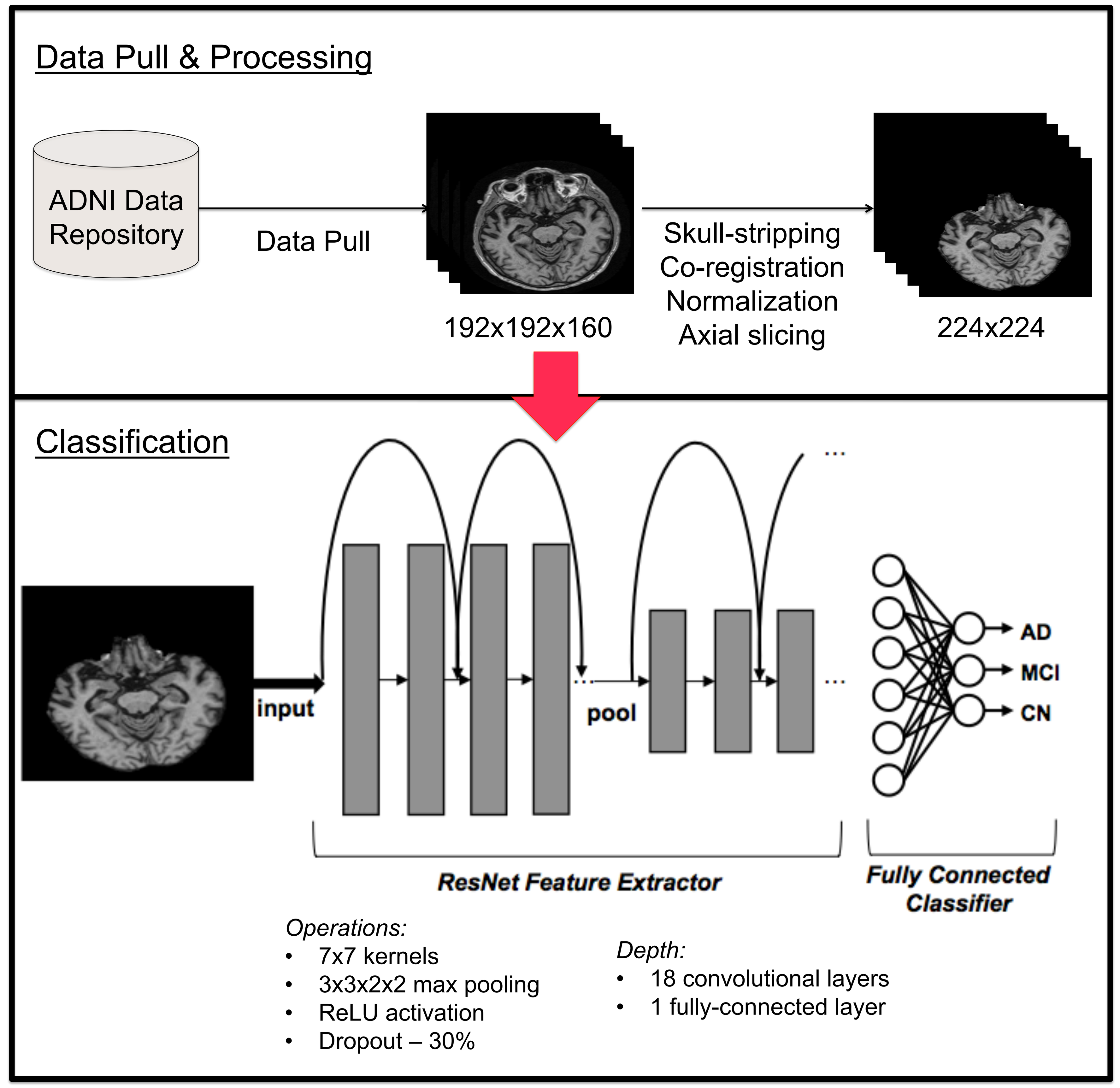
Question 2

Does pretraining influence ResNet's success?

Question 3

Does data augmentation improve the ResNet's ability to adapt to MRI images?

Methods



Conclusion

Question 1

The ResNet architecture pretrained on natural images successfully adapts to the MRI domain and improves two and three-way classification accuracy.

Question 2

Both the deep residual architecture and pretraining improve two and three-way classification accuracy.

Question 3

Data augmentation improves two and three-way classification accuracy.

Significance

- Deep pretrained networks are useful tools to overcome severe data limitations.
- Real-time data augmentation enhances model generalizability and is a strategy to avoid over-fitting on small amounts of training data.
- These techniques enhance our ability to model medical data and improve our ability to diagnose Alzheimer's disease and potentially other conditions.

Results

Model	AD vs. CN	AD vs. MCI vs. CN
Baseline CNN	73.8%	49.2%
ResNet	77.5%	50.8%
Pretrained ResNet	78.8%	56.1%
Pretrained ResNet + aug.	**81.3%**	**56.8%**

Table 1. Classification accuracy of Alzheimer's disease (AD), mild cognitive impairments (MCI) and cognitively normal (CN) brain MRIs. Performance across two-way (AD vs. CN) and three-way classification (AD vs. MCI vs. CN) was assessed. The pretrained ResNet architecture with data augmentation provides the best classification accuracy across both two-way and three-way classification tasks.

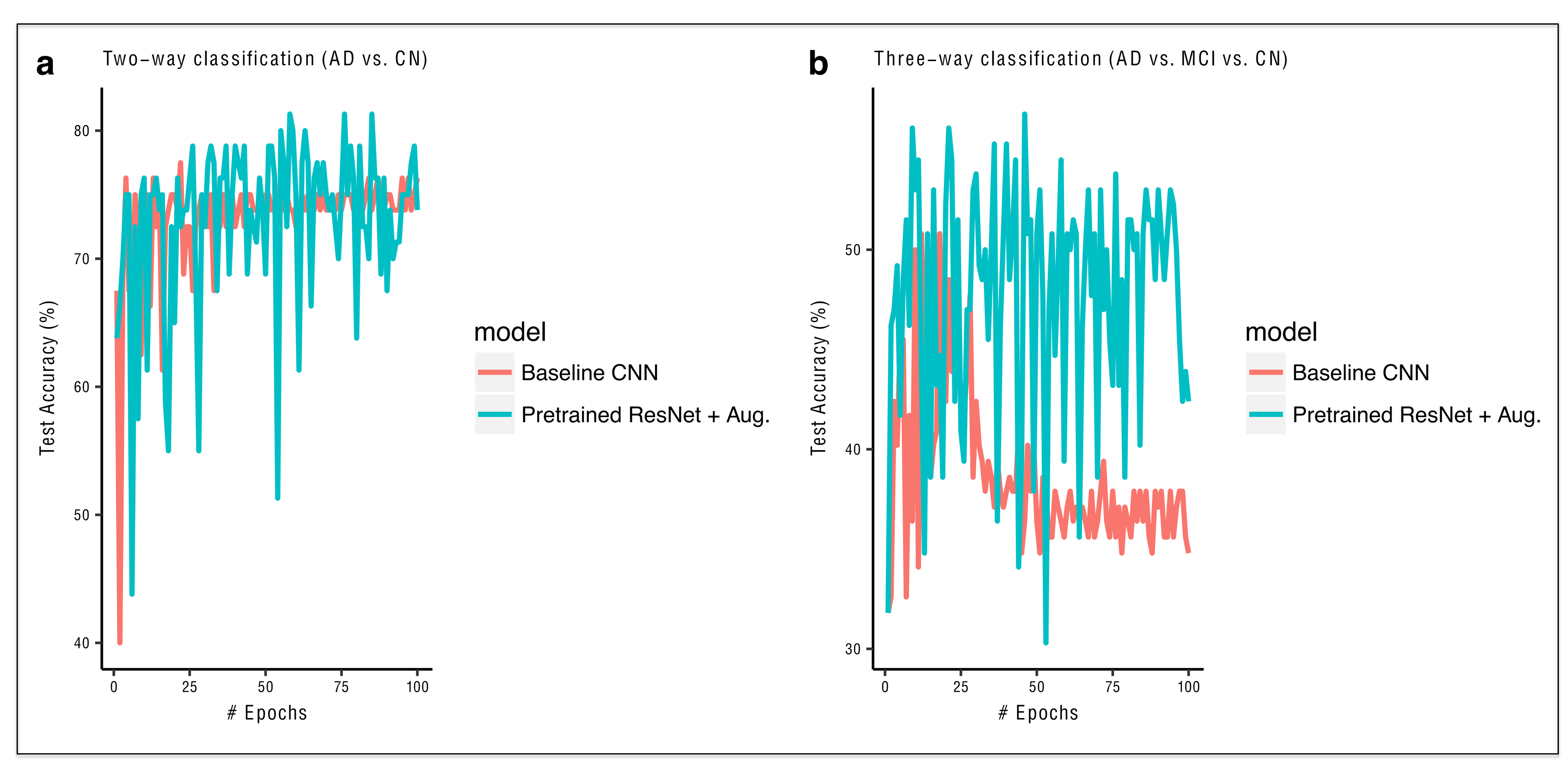


Figure 1. Learning curves of baseline CNN and pretrained ResNet with data augmentation across (a) two-way and (b) three-way classification. The pretrained ResNet architecture provides superior test accuracy and is less prone to over-fitting, especially in three-way classification.

Future Research

- Explore role of pretraining vs. depth.
- Extend the network to use 3D convolutions to account for the spatial nature of MRIs.
- Semi-supervised learning strategies using generative models as an additional strategy to overcome data limitations.
- Answer the more important medical question of early diagnosis: can we predict which patients with mild cognitive impairments are likely to develop Alzheimer's disease?

References

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