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.

Results

<table>
<thead>
<tr>
<th>Model</th>
<th>AD vs. CN</th>
<th>AD vs. MCI vs. CN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline CNN</td>
<td>73.8%</td>
<td>49.2%</td>
</tr>
<tr>
<td>ResNet</td>
<td>77.5%</td>
<td>50.8%</td>
</tr>
<tr>
<td>Pretrained ResNet</td>
<td>78.8%</td>
<td>56.1%</td>
</tr>
<tr>
<td>Pretrained ResNet + aug.</td>
<td>81.3%</td>
<td>56.8%</td>
</tr>
</tbody>
</table>

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.

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 pretrained 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.

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