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Transfer Learning for Alzheimer's Disease Detection: Adapting Video Classification Models for MRI Scans

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4.1 Data Acquisition and Characteristics

The Alzheimer's Disease Neuroimaging Initiative (ADNI) database served as the primary data source for this study. ADNI represents a comprehensive, longitudinal dataset specifically designed for Alzheimer's disease research, offering rigorously standardized MRI acquisitions with corresponding clinical diagnoses and metadata.

4.1.1 Dataset Selection and Access

After evaluating potential neuroimaging repositories (including OASIS), ADNI was selected for its comprehensive coverage, standardized acquisition protocols, and expert-validated diagnoses. Access was obtained through a formal application process describing the research objectives. The analysis initially utilized data from ADNI-1, later expanding to incorporate volumes from ADNI-2, ADNI-3, and ADNI-4 to increase sample diversity and size.

4.1.2 Image Acquisition Parameters

All selected scans were T1-weighted Magnetization Prepared Rapid Gradient Echo (MPRAGE) sequences, chosen for their:

- Optimal gray/white matter contrast, facilitating hippocampal visualization
- Standardized acquisition parameters across multiple ADNI sites
- High signal-to-noise ratio for structural analysis
- Widespread clinical availability and established role in AD assessment
- Sensitivity to hippocampal atrophy, a primary biomarker for AD progression

The T1w MPRAGE sequences typically featured:

- 1.5T or 3T field strength
- $\sim$1mm^3 isotropic resolution

- Acquisition matrix of approximately 256×256×170
- TR/TE parameters standardized according to ADNI protocol

4.1.3 Subject Demographics and Diagnostic Criteria

Subjects were classified into two distinct diagnostic categories:

- Alzheimer's Disease (AD): Subjects meeting NINCDS-ADRDA criteria for probable AD
- Cognitively Normal (CN): Control subjects without significant cognitive impairment

The original dataset distribution was approximately 33% AD and 67% CN cases. After running tests with this distribution, I suspected large amounts of overfiitng as discussed later, during methods to prevent this overfitting, more scans were included and processed. While increasing the scan pool, to address this imbalance and optimize model training, all available new AD scans were incorporated, with CN subjects sampled to achieve a final balanced 50/50 distribution.

4.1.4 Data Distribution Analysis

The final dataset contained 1,300 T1w MRI scans from 408 unique subjects:

- AD cohort: 650 scans from 203 subjects
- CN cohort: 650 scans from 205 subjects

Following subject-level splitting (detailed in Data Splitting Strategy section), the distribution across partitions was:

- Training set: 1,023 scans (512 AD, 511 CN) from 248 subjects (133 AD, 115 CN)
- Validation set: 139 scans (69 AD, 70 CN) from 80 subjects (35 AD, 45 CN)
- Test set: 138 scans (69 AD, 69 CN) from 80 subjects (35 AD, 45 CN)

This distribution ensured that each partition contained sufficient samples for robust model training and evaluation while maintaining diagnostic balance. The deliberate focus on AD versus CN classification (excluding Mild Cognitive Impairment) reflects the clearer structural changes observable in established AD, particularly the hippocampal atrophy that serves as a primary biomarker for disease progression.