The Development of Neural Network Inversions on Synthetic MRI Data Masks to Accurately Estimate Brain Tissue Stiffness Indicative of Alzheimer's Dementia

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Abnormally stiff brain tissue is associated with neural damage and can indicate Alzheimer’s dementia, other dementias, and normal pressure hydrocephalus. Currently, early Alzheimer’s diagnosis is conducted with inadequate, qualitative mental interviews that are not applicable to all patients. Magnetic Resonance Elastography (MRE)—a subsection of MRI that identifies tissue stiffness—creates a numerical measurement that can indicate forms of dementia and increase chances of early diagnosis. However, the traditional MRE method of direct inversion (DI) tested on in vivo MRIs yielded a low correlation of 0.49 and is biased around the brain’s edges. Thus, training neural network inversions (NNIs) on MRIs could increase stiffness estimation accuracy and generalization. Training NNIs on artificial data could also produce higher accuracy and generalization than previously described models. The dataset contained 5 regions per 85 peoples’ in vivo MRI masks, the workable 3D representations of the brain. Seven main NNIs were trained through an Inception-like convolutional architecture: no-masks (NM), all-masks (AM), one-person’s masks (OPM), one-region’s masks (ORM), randomized-masks (RandM), and artificial-masks (ArtifM). The models were tested on three datasets: AM, OPM, and ORM. The coefficients of determination were found to be: NM-0.42, AM-0.99, OPM-0.98, ORM-0.99, RandM-0.95, ArtifM-0.83. In summary, the NNI significantly estimated brain tissue stiffness more accurately than DI, while increasing generalization and decreasing bias, and proves to be a potentially accurate, efficient MRE technique for early Alzheimer’s dementia diagnosis. The NNIs in this study have real-world implications on decreasing time and manpower spent, improving early diagnosis of Alzheimer’s dementia.