Simulating progressive neurodegeneration in silico with deep artificial neural networks

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Abstract

We recently proposed a novel paradigm of using convolutional neural networks (CNNs) to model information processing in the diseased brain. Previously, we simulated posterior cortical atrophy (PCA), a form of Alzheimer's disease primarily impacting the visual cortex and manifesting as visual cognition deficits, by ablating CNN weights. However, this approach modelled a synaptic ablation injury, which resulted in the rapid onset of functional impairments. Here, we investigate using a weight decay function to simulate a gradual synaptic injury. In contrast to ablation injury, the onset of functional deficits was slower with the proposed weight decay injury. If only a subset of the network weights were subject to a decay injury, the delayed onset of functional deficits was even more pronounced. This approach may better reflect the subtle atrophy that precedes symptoms and the gradual onset of functional impairments seen in patients with neurodegenerative diseases such as PCA and Alzheimer's disease.

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