AI-generated content model applied to brain image computing for Alzheimer's disease analysis

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Generative artificial intelligence (AI), utilizing deep learning to generate a patient's brain network from multimodal images, has a valuable

application in brain network analysis. However, existing data-driven models face challenges, such as relying heavily on extensive high-quality images, potentially resulting in suboptimal models and a failure to accurately assess evolving characteristics in brain networks.

Moreover, these models lack interpretability, which hinders the reasonable interpretation of abnormal connectivity patterns with biological significance and the uncovering of cognitive disease mechanisms.

Alzheimer's disease, marked by structural and functional connectivity alterations in the brain during its degenerative progression, underscores the importance of multimodal image fusion in diagnosis and brain network analysis.

In a study published in *IEEE Transactions on Cybernetics*, a research team led by Prof. Wang Shuqiang from the Shenzhen Institute of Advanced Technology (SIAT) of the Chinese Academy of Sciences introduced a Prior-Guided Adversarial Learning with Hypergraph (PALH) model for predicting abnormal connections in Alzheimer's disease.

This model integrates anatomical knowledge and multimodal images, generating a unified connectivity network with high-quality and biological interpretability through the AI-generated content (AIGC) model.

PALH comprises a prior-guided adversarial learning module and a hypergraph perceptual network. The prior-guided adversarial learning leverages anatomical knowledge to estimate the prior distribution and employs an adversarial strategy to learn latent representations from multimodal images. Simultaneously, the pairwise collaborative discriminator (PCD) enhances the model's robustness and generalization

by associating the edge and joint distribution of the imaging and representation spaces.

Furthermore, the hypergraph perceptual network (HPN) was introduced to establish high-order relations between and within multimodal images, enhancing the fusion effects of morphology-structure-function information. HPN proved instrumental in capturing abnormal connectivity patterns at different stages of Alzheimer's disease, improving prediction performance and aiding in the identification of potential biomarkers.

By modeling a complex multilevel mapping of structure-function-morphology information, PALH significantly enhances Alzheimer's disease diagnosis performance and identifies relevant connectivity patterns associated with the disease progression.

"The proposed model is a unified prior-guided AIGC framework applied for the first time to evaluate changing characteristics of brain connectivity at different stages of Alzheimer's disease," said Zuo Qiankun, the first author of this study.

More information: Qiankun Zuo et al, Prior-Guided Adversarial Learning With Hypergraph for Predicting Abnormal Connections in Alzheimer's Disease, *IEEE Transactions on Cybernetics* (2024). DOI: 10.1109/TCYB.2023.3344641

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