Deep Generative Modelling for Robust fMRI Denoising

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Functional Magnetic Resonance Imaging (fMRI) is pivotal in understanding brain activity, but its efficacy is often hampered by slice-timing correction artifacts known as 'zebra-artifacts'. This study introduces a novel generative AI model to reconstruct blood-oxygen level dependent (BOLD) signals from corrupted fMRI data, focusing on the V1 primary visual cortex in marmoset models. Utilizing a dataset from the Jasanoff Lab at MIT, this research employed a two-pronged computational approach. Firstly, a synthetic dataset mimicking hemodynamic responses in the visual cortex was created to provide controlled testing conditions. Secondly, temporal signal-to-noise ratio (tSNR) analysis was used to quantitatively assess the model's performance in reconstructing accurate BOLD signals from both original and artificially corrupted datasets. The generative AI model demonstrated significant proficiency in reconstructing BOLD signals, as evidenced by improved tSNR in the processed data compared to the original. This indicates successful reduction of noise and artifact effects, suggesting the model's capability in recovering true BOLD signals from corrupted fMRI data.The proposed AI model shows promise in enhancing the accuracy and reliability of fMRI data analysis, particularly in scenarios compromised by slice-timing correction artifacts. This advancement holds potential for substantial improvements in neurological research and clinical diagnoses, enabling more precise identification of brain functions with reduced data collection requirements.