#92 Brain Diffuser: An End-to-End Brain Image to Brain Network Pipeline

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Abstract

Brain network analysis is essential for diagnosing and intervention for Alzheimer's disease (AD). However, previous research relied primarily on specific time-consuming and subjective toolkits. Only few tools can obtain the structural brain networks from brain diffusion tensor images (DTI). In this paper, we propose a diffusion based end-to-end brain network generative model Brain Diffuser that directly shapes the structural brain networks from DTI. Compared to existing toolkits, Brain Diffuser exploits more structural connectivity features and disease-related information by analyzing disparities in structural brain networks across subjects. For the case of Alzheimer's disease, the proposed model performs better than the results from existing toolkits on the Alzheimer's Disease Neuroimaging Initiative (ADNI) database.

Conclusion

This paper presents Brain Diffuser, a novel approach for directly generating structural brain networks from DTI. Brain Diffuser provides an entire pipeline for generating structural brain networks from DTI that is free of the constraints inherent in existing software toolkits. Our method enables us to study structural brain network alterations in MCI patients. Using Brain Diffuser, we discovered that the structural connectivity of the subjects' brains progressively decreased from NC to EMCI to LMCI, which is in accordance with previous neuroscience research. Future studies will locate which brain regions of AD patients exhibit the most significant changes in structural connectivity.

Acknowledgement

This work is supported in part by the National Natural Science Foundations of China under Grant 62172403, in part by the Distinguished Young Scholars Fund of Guangdong under Grant 2021B1515020019, in part by the Excellent Young Scholars of Shenzhen under Grant RCYX20200714114641211 and in part by Shenzhen Key Basic Research Project under Grant JCYJ20200109115641762, in part by the University of Macau under Grant MYRG2022-00190-FST, in part by the Science and Technology Development Fund, Macau SAR, under Grant 0034/2019/AMJ and Grant 0087/2020/A2.

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Methodology

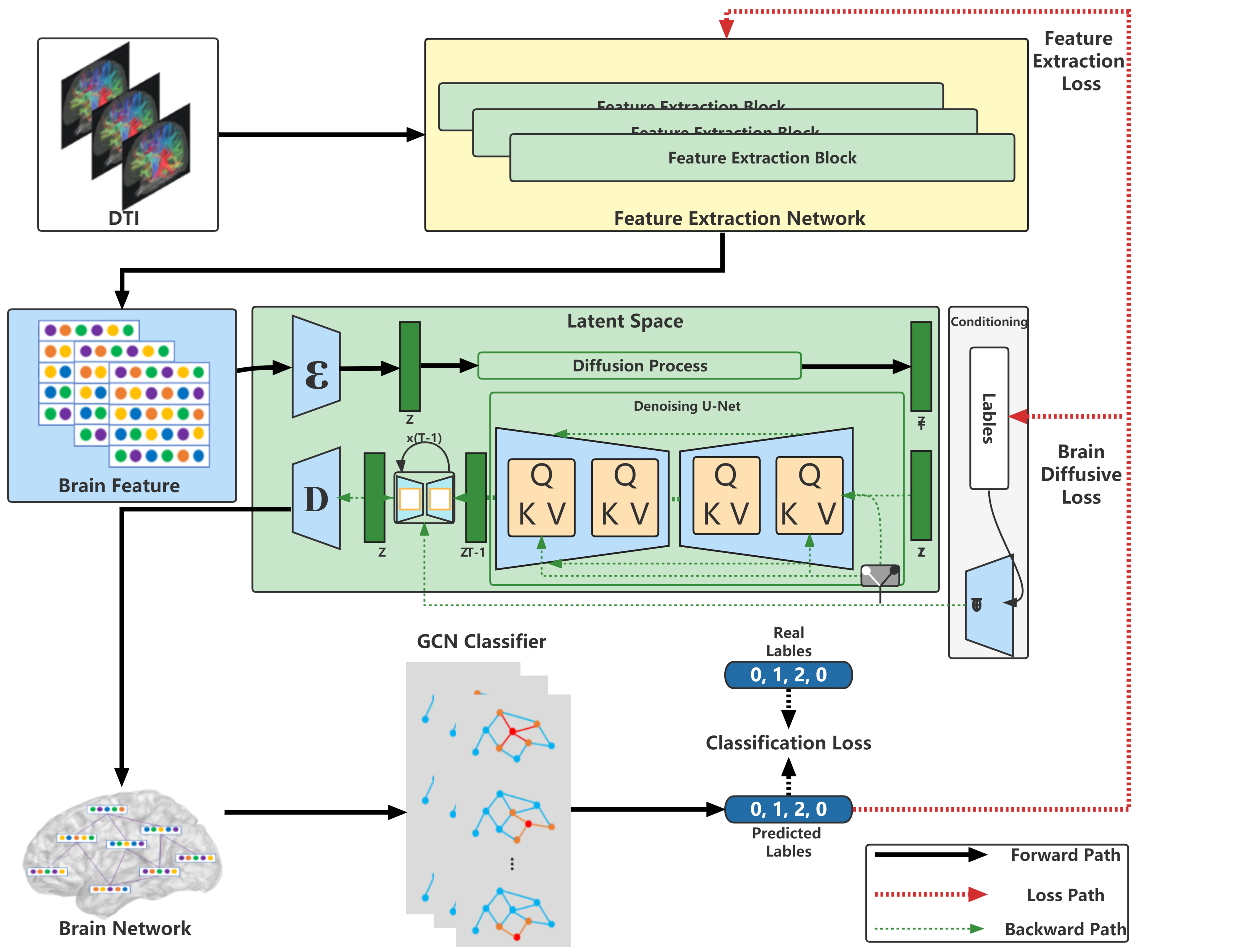

Figure 1: The overall architecture of our Brain Diffuser. Feature extraction network is applied to DTI images to extract brain network topology features. After passing the features to the diffusion model, a complete brain network is synthesized. The GCN classifier will incorporate classification knowledge to improve feature extraction and diffusion model further.

Analysis

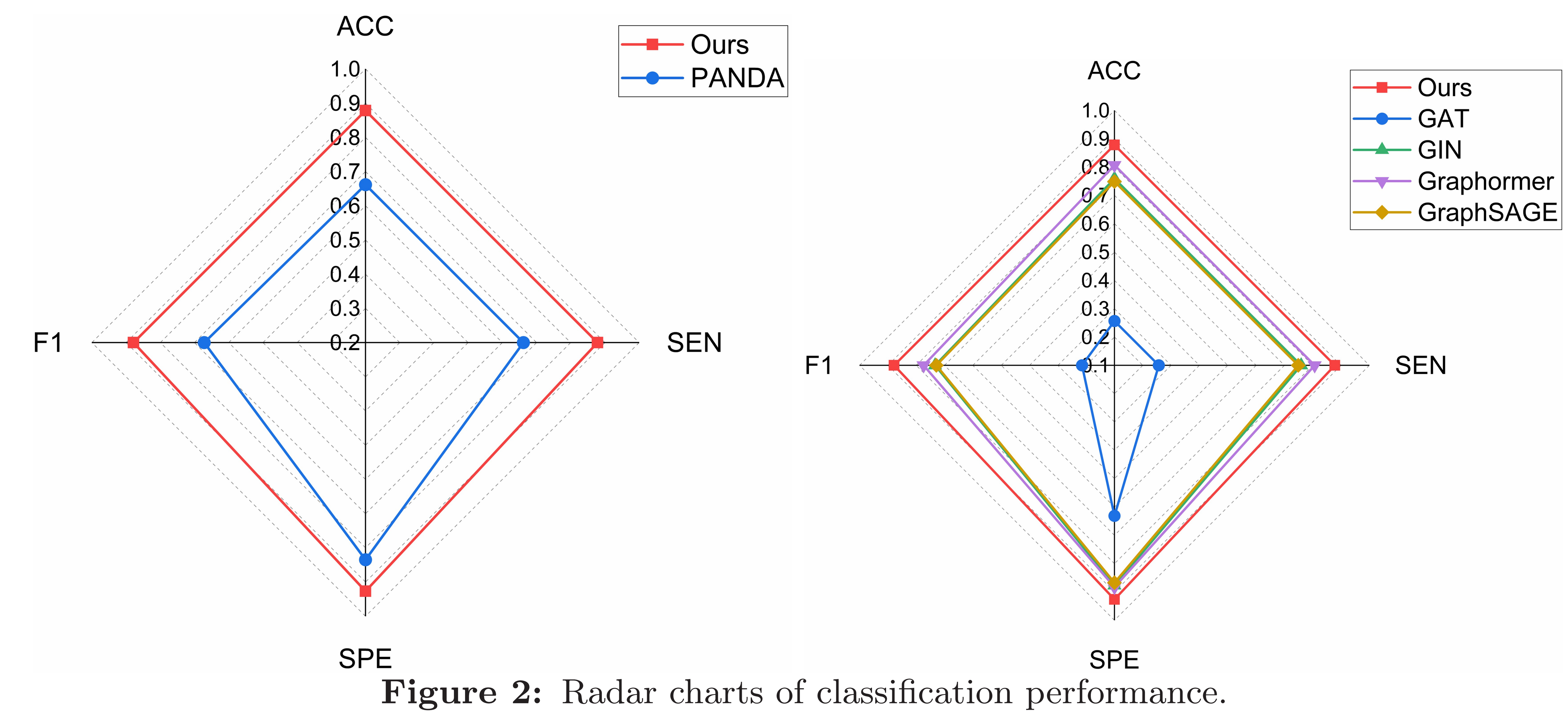

Figure 2: Radar charts of classification performance.

The results depicted in Figure 2 illustrate that our reconstructed results surpass those produced by the PANDA toolkit. This implies that our reconstruction pipeline presents considerable benefits for classifiers identifying potential MCI biomarkers. The performance of our generator markedly excels over PANDA, indicating significant potential for future research in AD detection and intervention. The ablation study presented in Figure 2 affirms that our classifier outperforms its counterparts, suggesting that our classifier can effectively harness a larger number of disease-related features or prospective disease-related biomarkers.

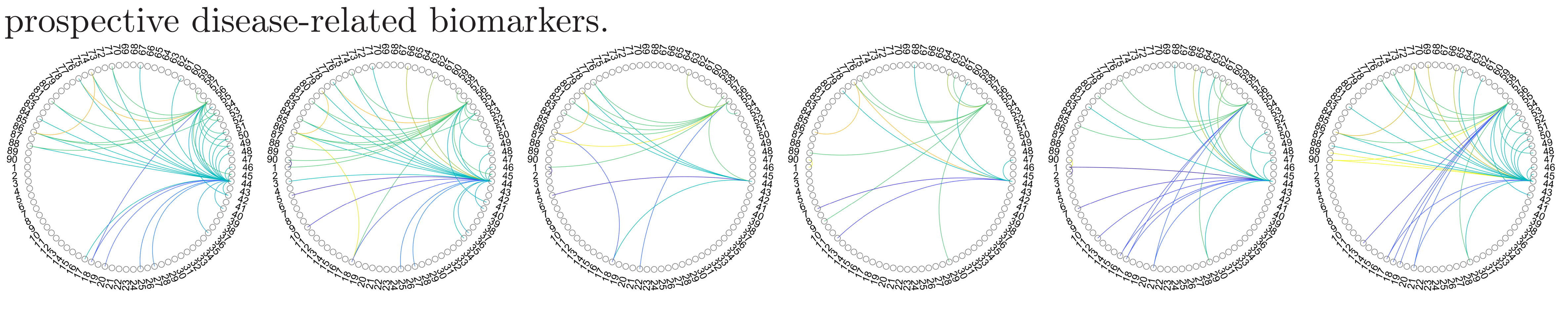

Figure 3: Chord diagrams of connectivity change.

Figure 3 contrasts the alterations in brain connectivity across different stages. The shift in connectivity between brain regions is more salient in the LMCI stage than in the NC stage. Similarly, there exists a substantial diminution in connectivity between brain regions in LMCI patients relative to EMCI patients. These modifications and trends unveil a sequential progression towards AD pathology in NC subjects, characterized by a progressive depletion in structural brain connectivity.