ParkBD: A Novel Multi-Modal Deep Learning Framework for Parkinson's Disease Severity Prediction and Treatment Using Clinical and Blood-Based Biomarker Data

Jonnalagadda, Shriya (School: Brookfield High School)
Girish Kumar, Diya (School: Brookfield High School)

Parkinson's Disease (PD) is the second most prevalent progressive neurodegenerative disorder. The development of new therapeutic approaches requires a better understanding of the underlying mechanisms of PD and the identification of new biomarkers that can aid in disease monitoring and the development of targeted therapies. Blood-based biomarkers hold promise for PD prognosis, but their identification and use in disease prediction remain challenging due to PD’s complexity and heterogeneity. To address this challenge, we present ParkBD, a comprehensive deep learning framework that integrates clinical and blood-based biomarker data to provide a reliable and accurate prediction of PD severity over time. The framework included a biomarker discovery module that identified ten correlated blood-based biomarkers with PD using differential protein analysis and linear regression with ten-fold cross-validation. It also included a severity prediction module that utilizes a modified XGBoost classification algorithm with clinical and biomarker data to predict MDS-UPDRS values over time. We evaluated the performance of ParkBD on a dataset of PD patients and healthy controls and compared it to existing methods. Our results show that ParkBD outperforms similar methods for PD severity prediction, with an accuracy of 90%. We also identified a set of novel blood-based biomarkers that are highly correlated with PD and utilized existing machine learning models to rank effective drug compounds. ParkBD is a promising tool for the development of therapeutic approaches for PD and the implementation of disease management strategies that can help maintain function, delay disease progression, and improve the quality of life.