Developing a Novel Holistic, Personalized Dementia Risk Prediction Model via Integration of Machine Learning and Network Systems Biology Approaches

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The prevalence of dementia has increased over time as global life expectancy improves and populations age. An individual's risk of developing dementia is influenced by various genetic, lifestyle, and environmental factors, among others. Predicting dementia risk may enable individuals to employ mitigation strategies or lifestyle changes to delay dementia onset. Current computational approaches to dementia prediction only return risk upon narrow categories of variables and do not account for interactions between different risk variables. The proposed framework utilizes a novel holistic approach to dementia risk prediction and is the first to incorporate various sources of tabular environmental pollution and lifestyle factor data with network systems biology-based genetic data. LightGBM gradient boosting was employed to ensure validity of included factors.This approach successfully models interactions between variables through an original weighted integration method coined Sysable. Multiple machine learning models trained the algorithm to reduce reliance on a single model. The developed approach surpassed all existing dementia risk prediction approaches, with a sensitivity of 85%, specificity of 99%, geometric accuracy of 92%, and AUROC of 91.7%. A transfer learning model was also implemented. De-biasing algorithms were run on the model via the AI Fairness 360 Library. Effects of demographic disparities on dementia prevalence were analyzed to potentially highlight areas in need and promote equitable and accessible care. The resulting model was additionally integrated into a user-friendly app providing holistic predictions and personalized risk mitigation strategies. The developed model successfully employs holistic computational dementia risk prediction for clinical use.

Awards Won:

Association for Computing Machinery: Third Award of $1,500