Deriving a Novel Index for Objective Probabilistic Prediction of Parkinson's

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Introduction

- **Parkinson's Disease (PD)** is a progressive neurodegenerative disease characterized by tremors, dementia, and mood swings
- The **Unified Parkinson's Rating Scale (UPDRS)** is an index that assesses PD severity
- UPDRS is based on 16 subjective factors; due to this, it performs poorly at predicting PD likelihood
- In hopes of improving on current standard prediction indexes, we created STRIPE and PRISM
- **STRIPE (Statistical Tool for Risk Indexing and Parkinson's Evaluation)** is an objective index that uses only 14 variables for predicting PD onset. It can be combined with UPDRS to further improve prediction accuracy
- **PRISM (Parkinson's Risk Index via Survey Measurements)** is a simplified index that uses 12 objective binary factors designed for remote, baseline assessments

Methods

- **STRIPE:** Weighted via logistic regression optimization to maximize correlation with PD diagnosis
- **PRISM:** Subset of features from STRIPE (age, tremors, diabetes) with weights calculated similarly
- **Model-Based Evaluation:** Testing accuracy & correlation of indexes' feature coefficients using logistic regression, random forest, and gradient boosting classifiers
  - Classifiers determine indexes' accuracy for model-based usage, uses ROC AUC to check for overfitting
  - Pearson correlation assesses model performance for human usage

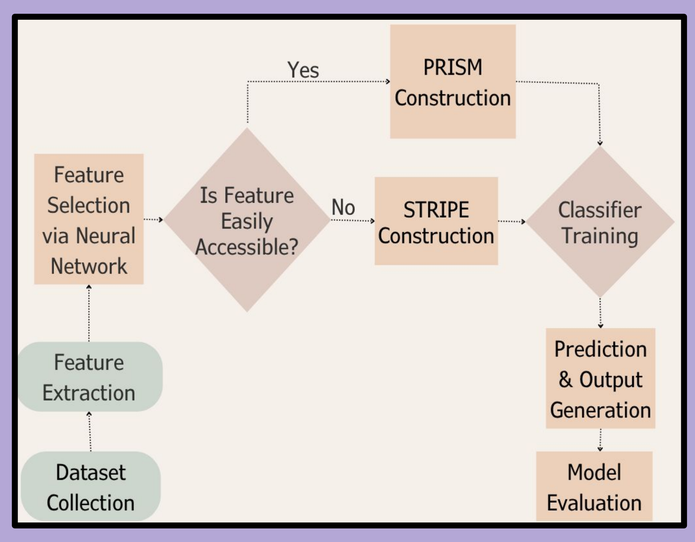

Figure 1: Methodology Pipeline for PD Diagnosis

Results

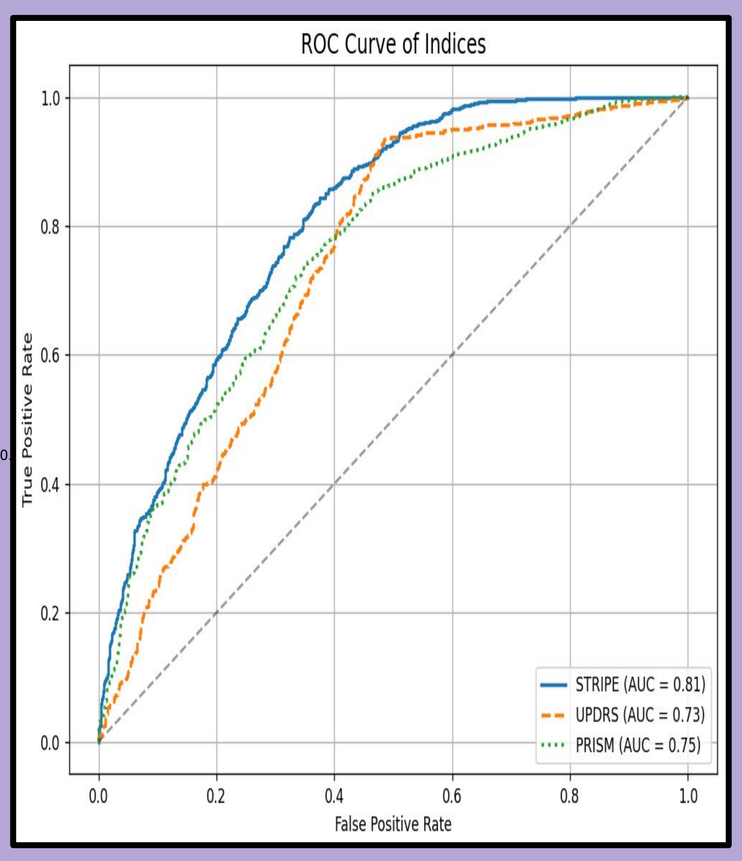

Figure 2: ROC (Receiver Operating Curve) Curve Showing Diagnostic Performance of UPDRS, STRIPE, & PRISM

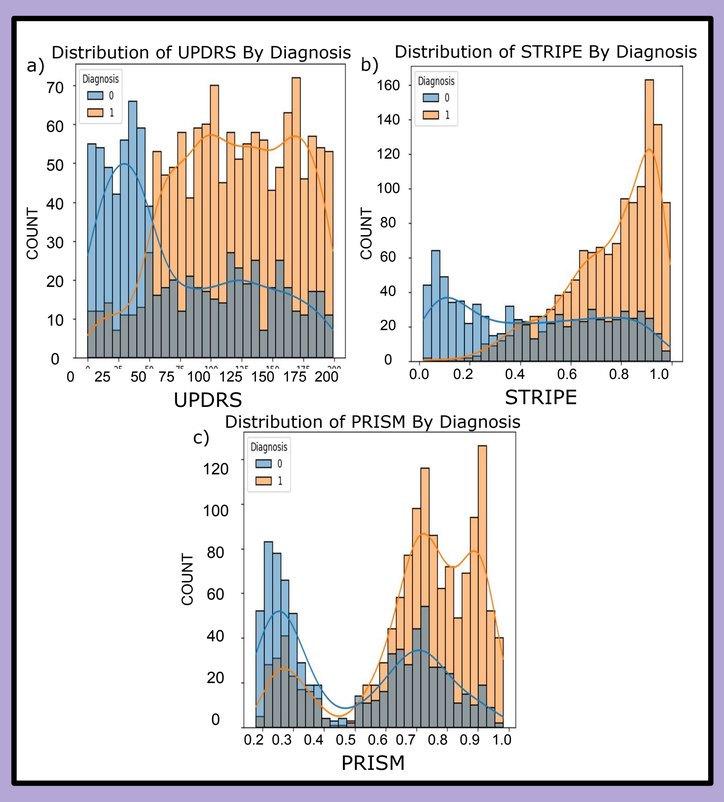

Figure 3: UPDRS, STRIPE, & PRISM index distribution across participants in highest-performing classifier

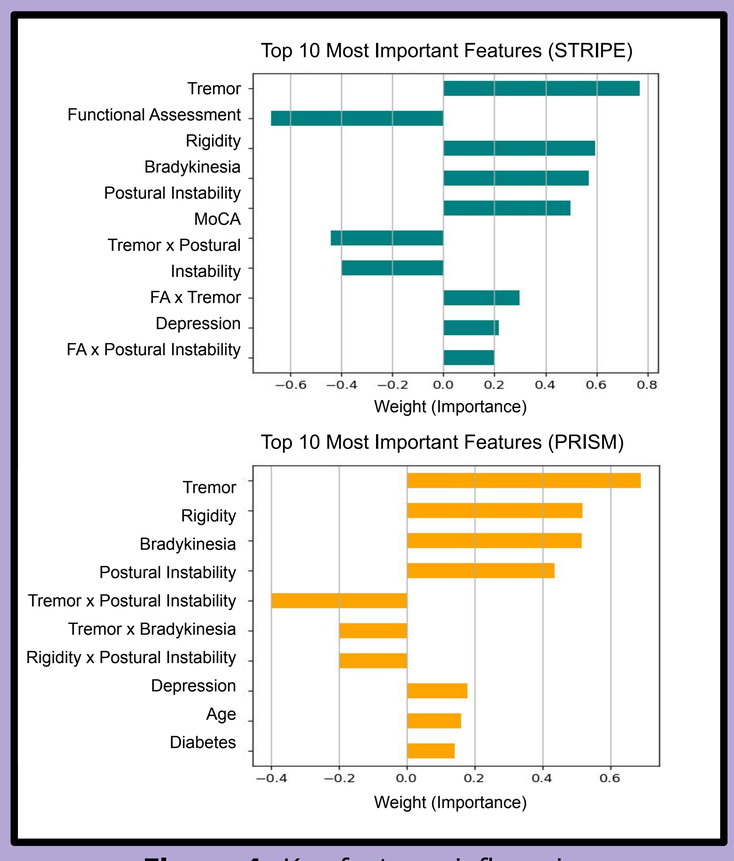

Figure 4: Key features influencing STRIPE & PRISM indices

Index Equations

STRIPE: Sigmoid(0.498 Pi + 0.770T - 0.674Fa - 0.439MoCA + 0.569Bk + 0.595R + 0.196A + 0.109D + 0.015FhP + 0.114Di + 0.091S - 0.001Sp - 0.089Sd + 0.3FaT + 0.2FaR + 0.2 FaBk + 0.2FaPi - 0.200TBk - 0.400TPi - 0.2RBk - 0.1AFa + 0.712)

PRISM: Sigmoid(0.436Pi + 0.690T + 0.515Bk + 0.519R + 0.161A + 0.089D + 0.029Fhp+ 0.089D + 0.141Di + 0.062S - 0.013Sp - 0.052Sd - 0.2TBk - 0.4TPi - 0.2RBk + 0.638)

Discussion

Significance: STRIPE and PRISM provide objective indexes that improve upon traditional PD diagnosis

- **Higher diagnostic accuracy:**
  - STRIPE and PRISM outperform UPDRS in both ROC AUC and correlation with diagnosis (0.553 vs 0.443 vs 0.398) (Figure 2)
  - STRIPE when combined with UPDRS yields performance accuracy of 87.7%: a significant improvement over individual model evaluations
- **Two indexes:** Despite lower accuracy (70% vs. 77%), the accessibility of the PRISM assesment makes it a worthy alternative to UPDRS. STRIPE acts as a secondary predictive measure, meeting UPDRS' accuracy

Limitations:

- Lacks external clinical or biomarker validation
- Dataset is very limited and could lead to coefficient overfitting

Future Applications:

- Validate STRIPE and PRISM using longitudinal clinical data
- Using STRIPE as a support tool for clinicians

References

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