NeuroPlay: A Multi-Modal Game-Based Diagnostic Tool for Early Detection and Staging for Parkinson's Disease

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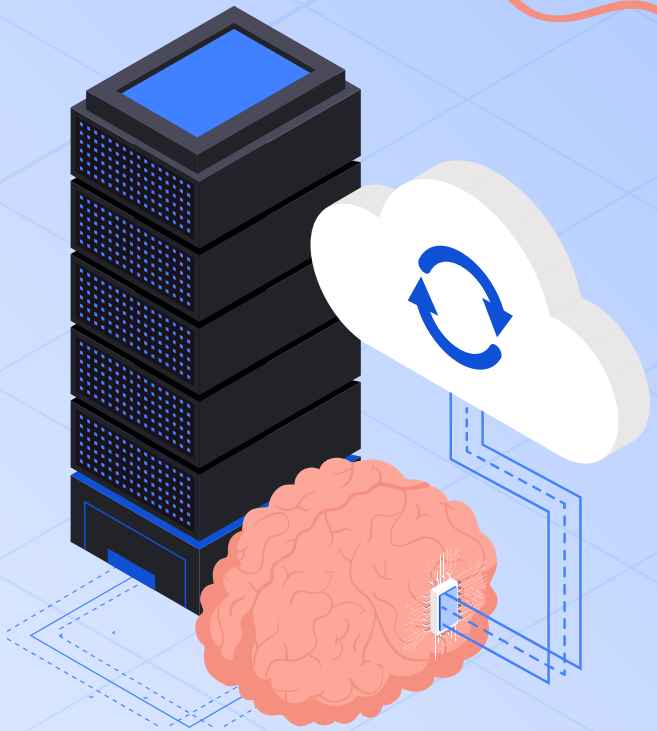


BWSI Medlytics 2025

Table of *Contents*

01

Background

The Problem

Parkinson’s Disease

Early Diagnosis

Accessibility

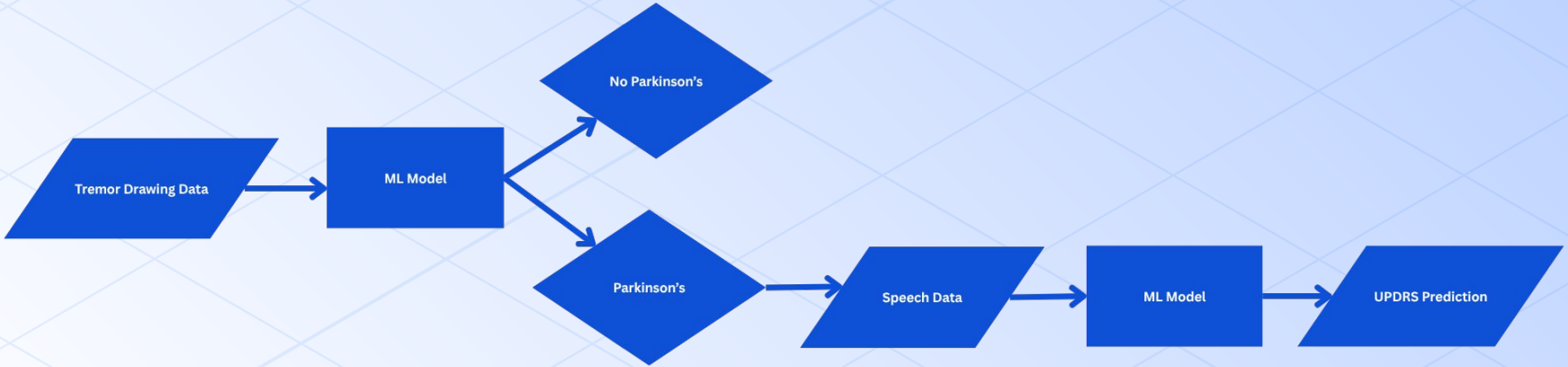
Our Goal

To develop a multimodal, game-based machine learning framework for accessible at-home screening and monitoring of Parkinson’s disease

02

Project Development

Proposed Pipeline



Tremor Model

Feature Engineering

- The *Parkinson Disease Spiral Drawings Using Digitized Graphics Tablet* dataset from UCI's ML repository
- X and Y coordinates and pressure →

Tremor Energy

Statistical Descriptors

Instantaneous Speed

Tremor Model

Training and Testing

- Stratified K-fold cross-validation (k=5)
- Logistic Regression
- XGBoost
- Random Forest

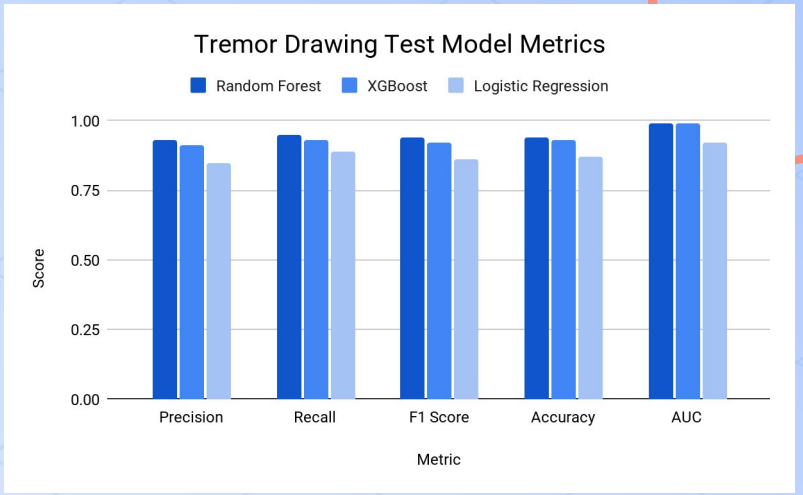
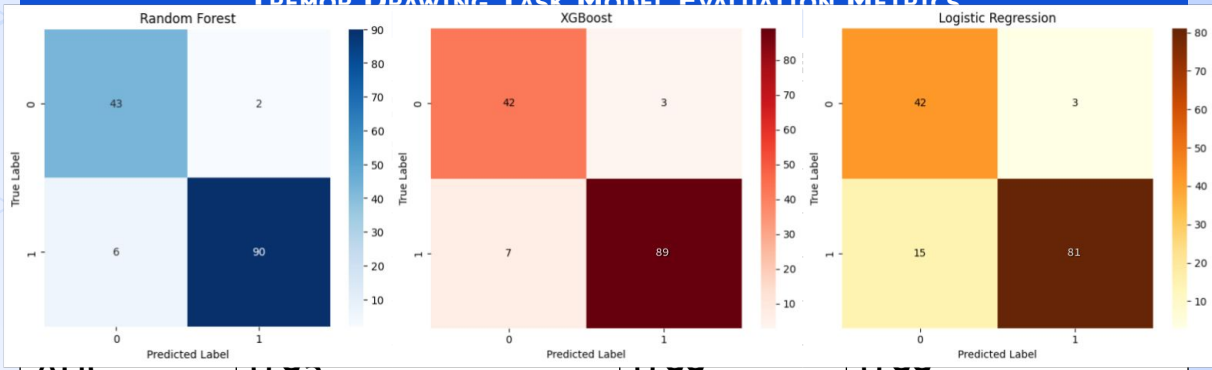


TABLE I

TREMOR DRAWING TASK MODEL EVALUATION METRICS



AUC	0.95	0.99	0.99

Voice Model

Feature Engineering

- The *Parkinson Telemonitoring* dataset from UCI's ML repository
- Voice features extracted from speech recordings of Parkinson's patients with UPDRS scores

Phonotation Stability

Complexity Features

Signal-to-Noise Measures

Voice Model - Regression

Training and Testing

- Train/Validation/Test Split (70/15/15)
  - Stratified using age
- Neural Network
- Random Forest

TABLE 2
VOICE REGRESSION TASK MODEL EVALUATION METRICS

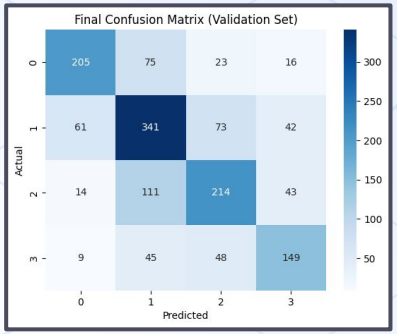
Metric	Voice Regression Test Model	
	Random Forest	Neural Network
R^2 Score	0.358	0.463
RMSE	8.394	7.677
MAE	6.477	5.836
Explained Variance	0.358	0.466

Voice Model - Classification

Training and Testing

- Train/Validation/Test Split (70/15/15)
- Neural Network Classification Model
- Partitioned Total UPDRS Score (Multi-Class)

4-way Split:



3-way Split:

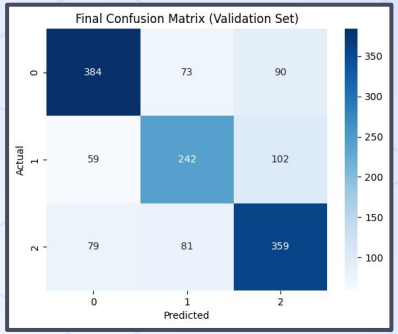


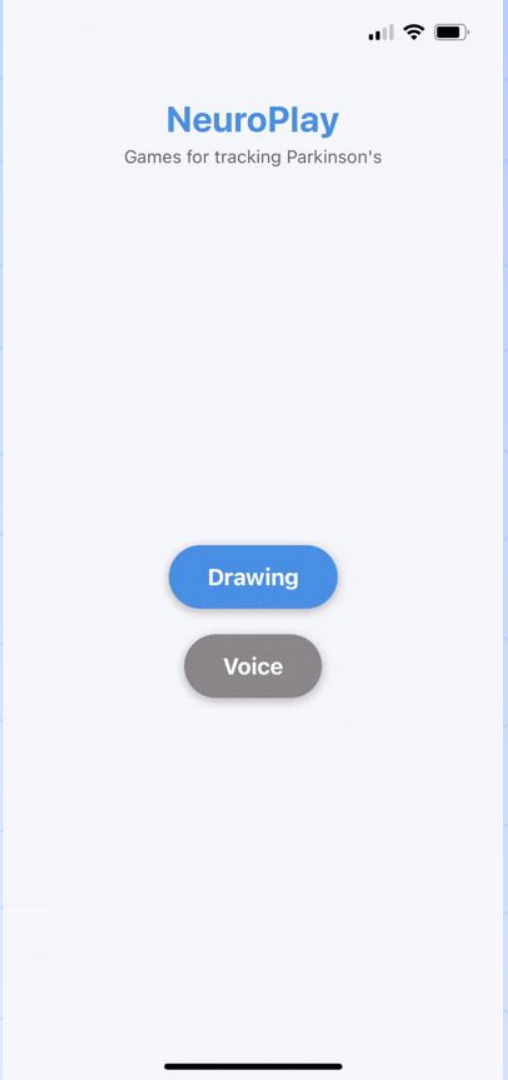
TABLE 3
VOICE CLASSIFICATION MODEL EVALUATION METRICS

Metric	Voice Classification Test	
	4-way Split	3-way Split
Precision	0.59	0.76
Recall	0.59	0.77
F1-score	0.59	0.73
Accuracy	0.59	0.74
M Average F1	0.58	0.72

App Interface

Prototyping

- **React Native framework**
- **Flask backend w/ Python**
- **Tremor:**
  - User draws a spiral on-screen
  - Compares drawn spiral to healthy baseline
  - Yes/No Parkinson’s diagnosis
- **Voice:**
  - User speaks prompted sentence
  - Analyzes vocal tremors, articulation, and pauses
  - UPDRS Score → Stage



03

Reflection

Overcoming *Challenges*

Challenge	Solution
Optimizing Models	Testing out multiple models, k-fold, stratification, feature engineering
Stage Uncertainty	Used Oxford voice data to estimate severity scores (UPDRS values).

04

The Future

Broader Range

- Expand model to other neurodegenerative diseases
- Design mini-games targeting other symptoms
- Offer accurate diagnosis despite overlapping symptoms
- Provide accessible, nuanced screening for patients

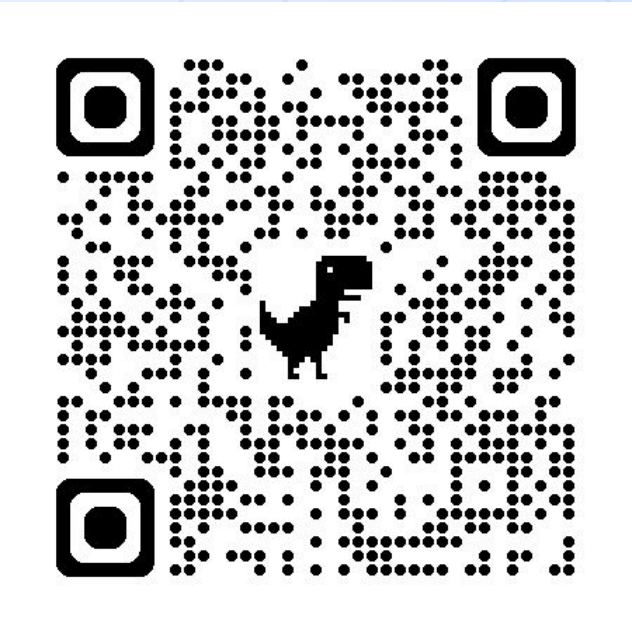
Mobile Launch

- Launch model as mobile diagnostic app
- Use gamified tools for user engagement
- Reduce stress of formal cognitive testing
- Detect disease early with home screening
- Prioritize senior-friendly, accessible interface design
- Bridge age gap with inclusive technology

Clinical Validation

- Current models use public dataset sources
- Plan clinical validation with UT Southwestern
- Partner with Peter O’Donnell Brain Institute
- Test on patients with varying stages
- Refine model using real clinical data
- Prove tool is reliable for screening

Thank you!



GitHub Repository

Questions?