

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

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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**



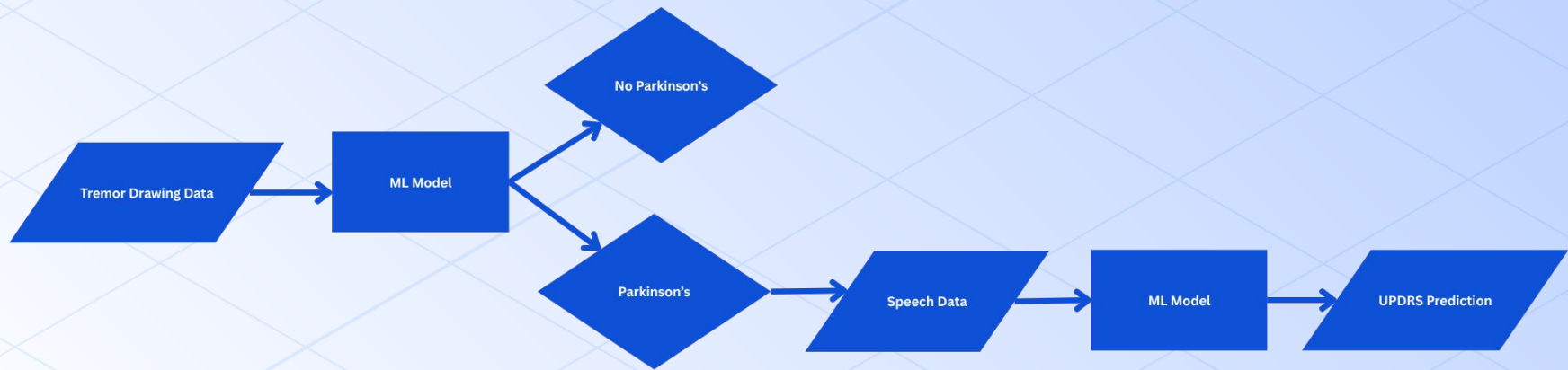
02



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**



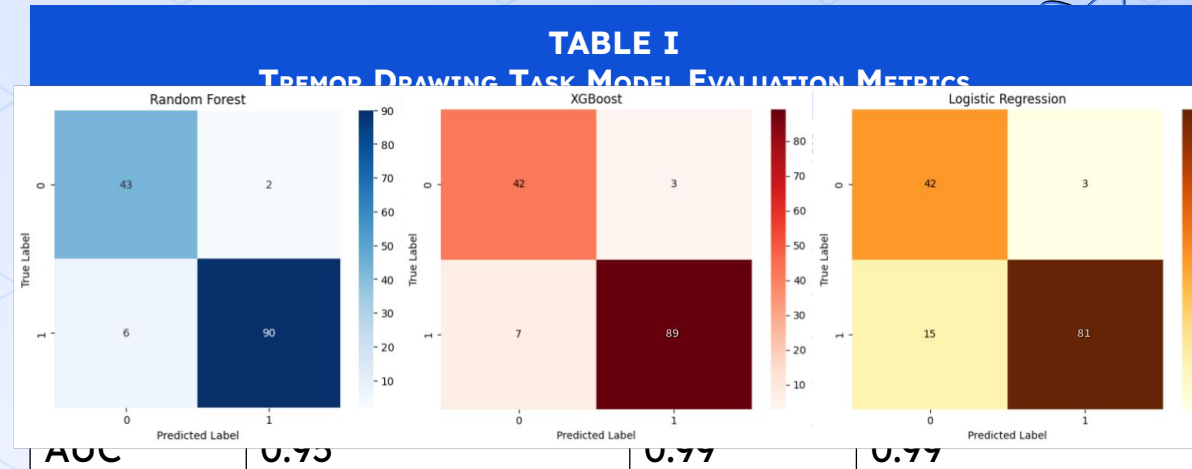
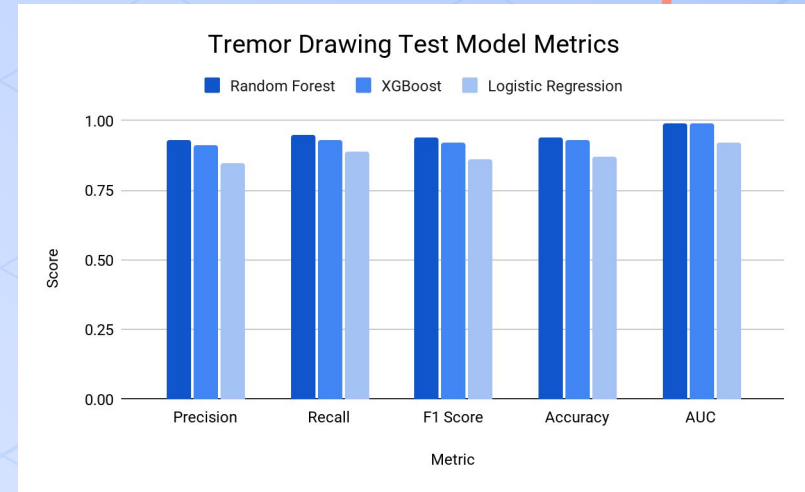
**Instantaneous
Speed**



Tremor Model

Training and Testing

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



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



**Phonotaxion
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**

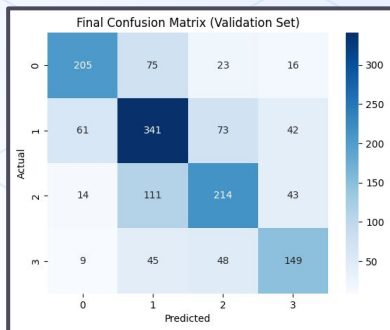
TABLE 2 VOICE REGRESSION TASK MODEL EVALUATION METRICS		
Metric	Voice Regression Test Model	
	Random Forest	Neural Network
R ² Score	0.358	0.463
RMSE	8.394	7.677
MAE	6.477	5.836
Explained Variance	0.358	0.466

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:

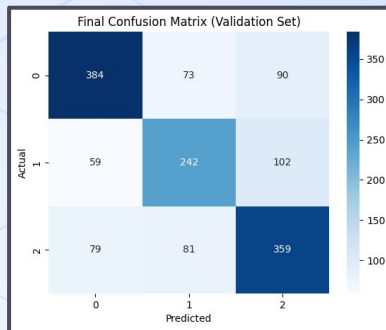


TABLE 3
VOICE CLASSIFICATION MODEL EVALUATION METRICS

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

NeuroPlay
Games for tracking Parkinson's

Drawing

Voice



03

Reflection



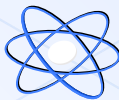
Overcoming *Challenges*

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

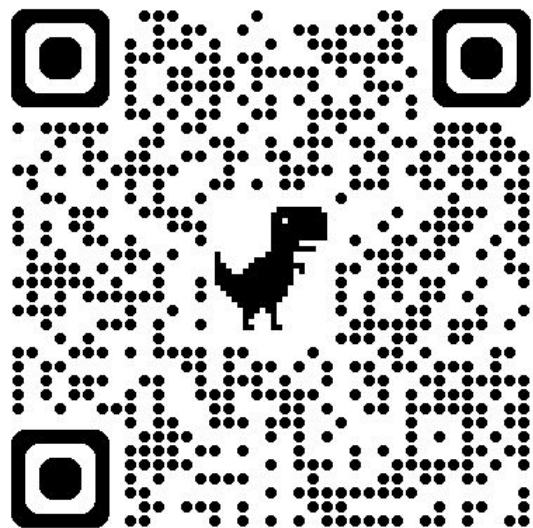


Clinical Validation

- 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?

