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ParkinsonAI

*An AI-powered Solution for Early Parkinson's Disease
Monitoring and Tracking*

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OUTLINE



ParkinsonAI

- ❖ Introduction & Background
- ❖ Methodology
- ❖ Initial Problems
- ❖ Results
- ❖ Conclusion
- ❖ Future Work
- ❖ Acknowledgement

INTRODUCTION

2nd

most common
neurodegenerative
disease in the US, after
Alzheimer's disease.

14th

leading cause of
death in the US.

Economic Burden of PD



1 Million

PD Patients



\$ 51.9 Billion*

Est. Annual Cost



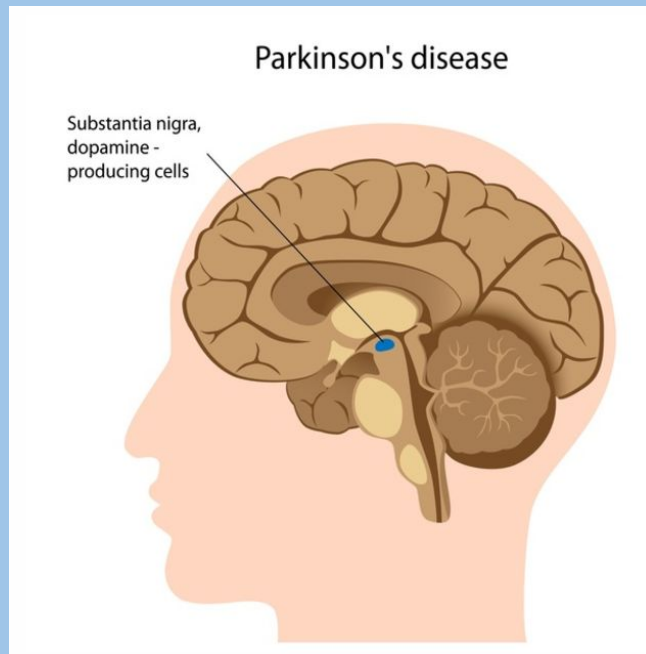
Double

By 2040

* Direct Medical Costs: \$26K Per Patient

INTRODUCTION

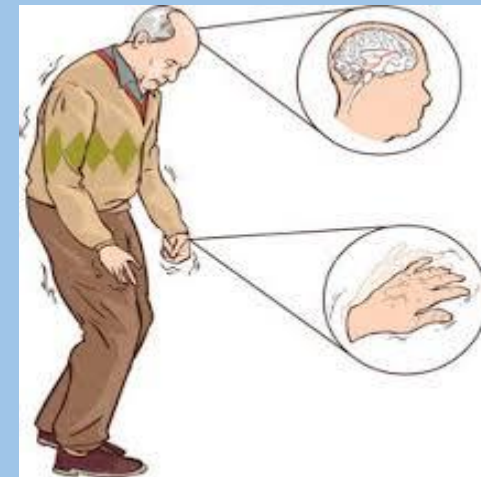
Cause



- ❖ Loss of dopamine-producing cells



Symptoms

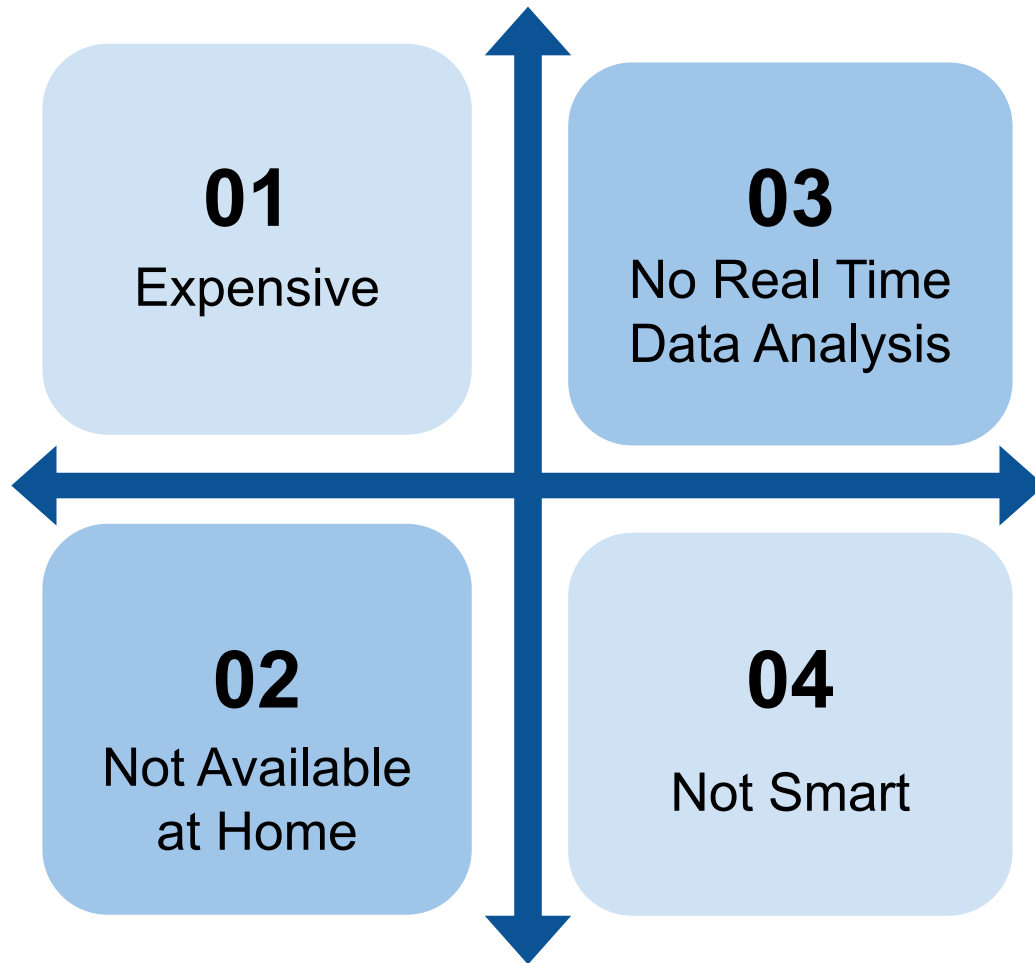


- ❖ Resting Tremors
- ❖ Bradykinesia
- ❖ Muscle rigidity
- ❖ Balance problems
- ❖ Postural instability

BACKGROUND



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- ❖ Cameras can catch the finite movement due to PD tremor
- ❖ Realtime data analysis can catch the characteristics of PD tremor
- ❖ Time series data fed into a trained Recurrent Neural Network (RNN) to accurately report daily updates and the severity of tremors



TECHNICAL CHALLENGES

The primary challenge of using a standard computer camera is its measurement reliability to capture small signals.

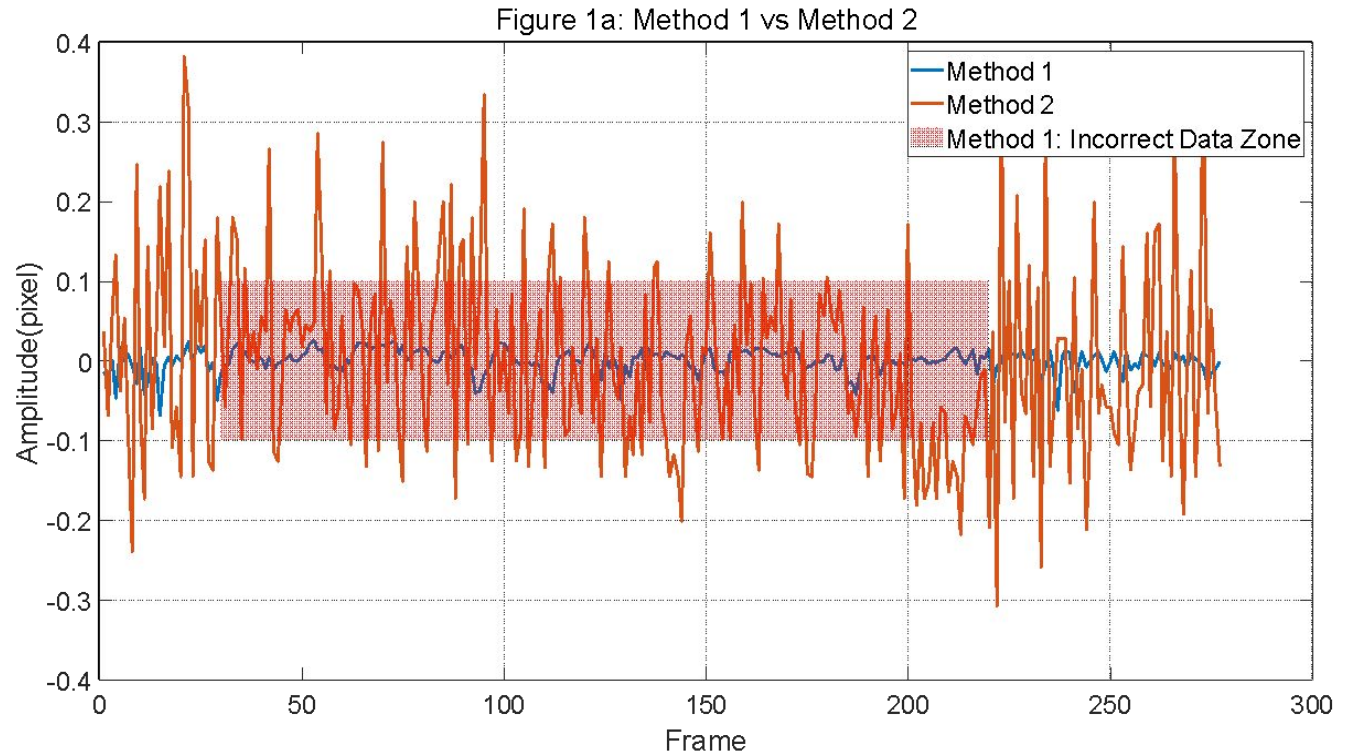
❖ Method 1 - Optical Flow

Processing:

- > highly precise under a good SNR: standard deviation < 0.1 pixels.
- > Fails to consistently capture the hand profile

❖ Method 2 - Google's Mediapipe

- > Bodymark capture AI engine
- > Models the object as a whole first and then calculates its motion.
- > Variation as low as 0.2-0.4 pixels



Method 1 fails
under:

Poor light conditions

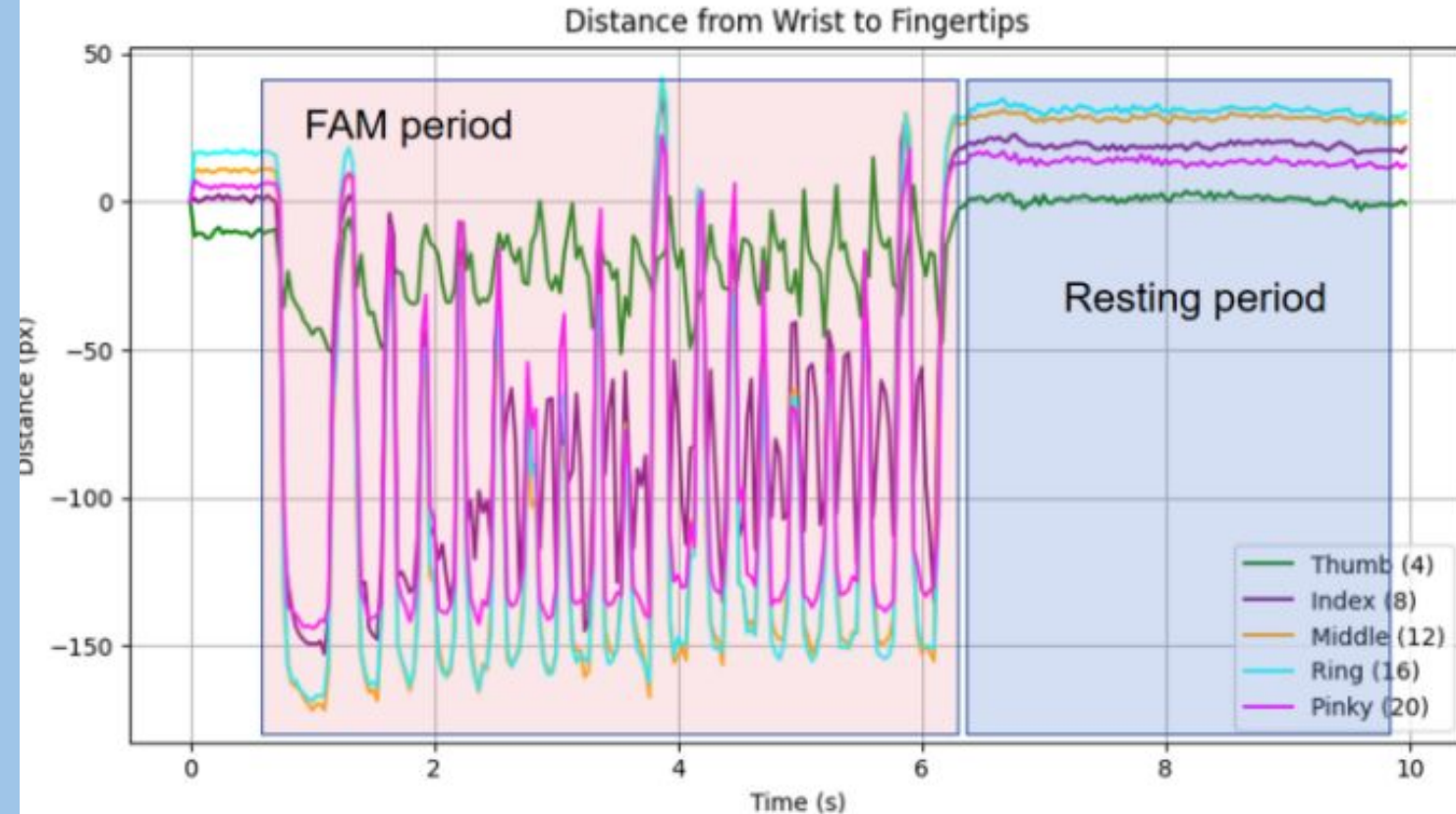
Variable distance

Uncertainty of the object speed.

Method 2 is more robust for complicated user environments.

IMPROVED FAM PROCESS

- ❖ Fast Alternative Movement (**FAM**) is a standard process defined by the Movement Disorder Society-Unified Parkinson's Disease Rating Scale (MDS-UPDRS).
- ❖ We define FAM as rapid opening and closing of the hand.
- ❖ In addition, a resting period is added in the end thus able to catch resting tremor - key indicator of PD.

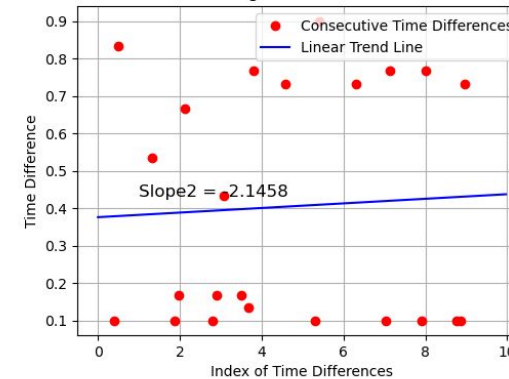
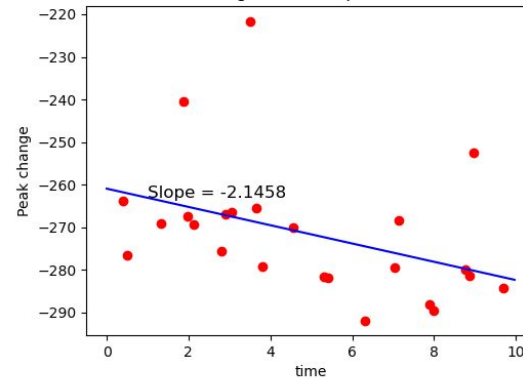
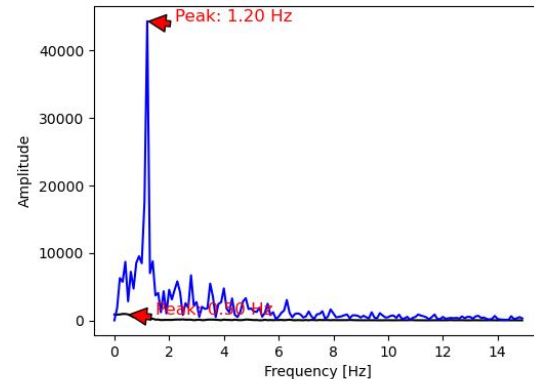
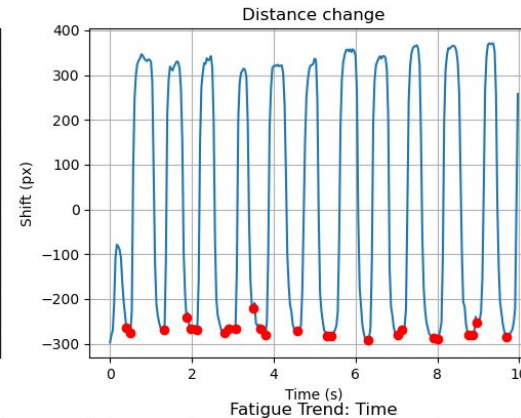
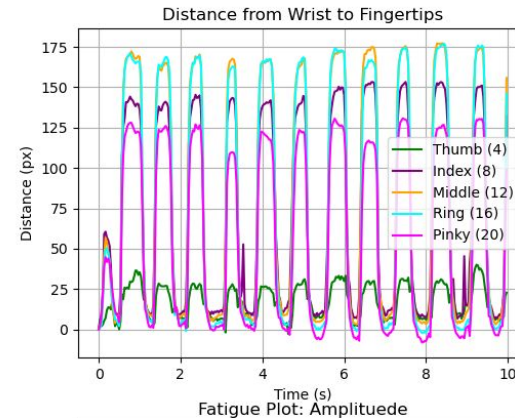
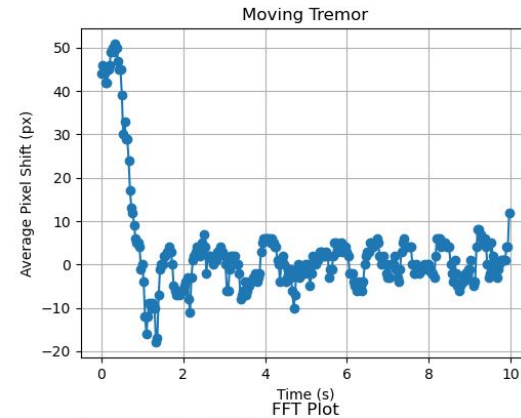


Example of improved FAM process

SAMPLE REPORT



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Key parameters

- ❖ Peak FAM frequency
- ❖ Resting Tremor frequency
- ❖ Peak value of FAM
- ❖ Amplitude Trend of FAM (Fatigue Scale 1)
- ❖ Spectrum spread of FAM (Fatigue Scale 2)
- ❖ Standard Deviation of Fatigue Scale 1
- ❖ Standard Deviation of Fatigue Scale 2



Finish

Peak Frequency: 1.20 Hz

Peak Amplitude: 44367.53

Fatigue 1: -2.15

Fatigue 1 Var: 237.69

Fatigue 2: 0.006151 Fatigue 2 Var: 0.096455

FIELD TESTING



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- ❖ Connected with **Howard County Senior English Class** group.
- ❖ Partnered with **Asian American Healthcare Center**
- ❖ **62** user data has been collected and trained for AI Model.



AI MODEL TRAINING



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Input Parameter

ID

Gender

Age

Collected and Calculated Parameter

Frequency

Amplitude

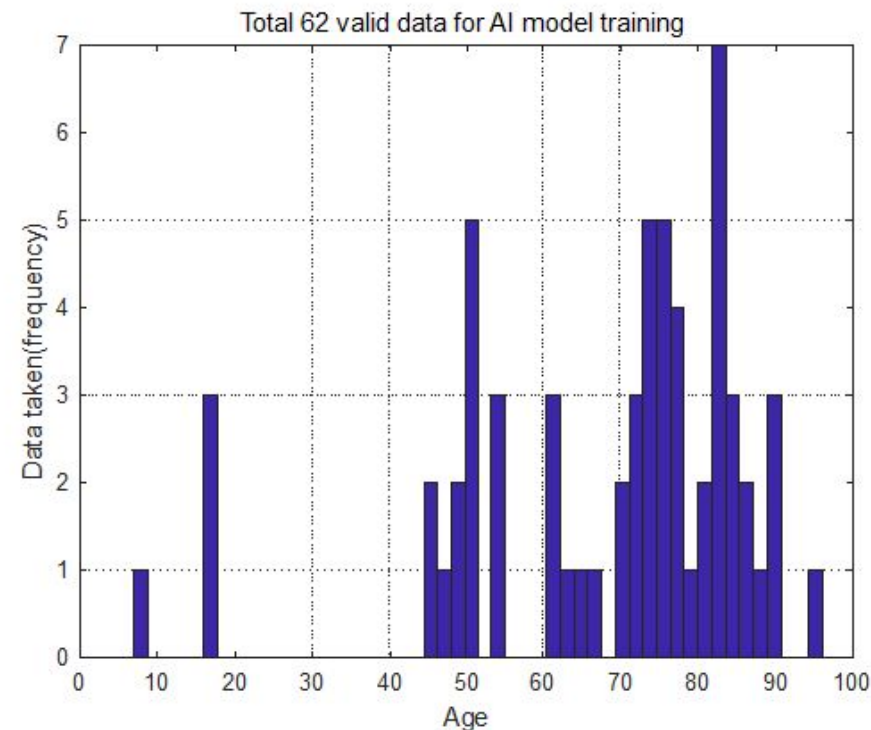
Fatigue Amplitude

F1_Std

Fatigue Time

F2_std

Index (Unified Parkinson's Disease Rating Scale)

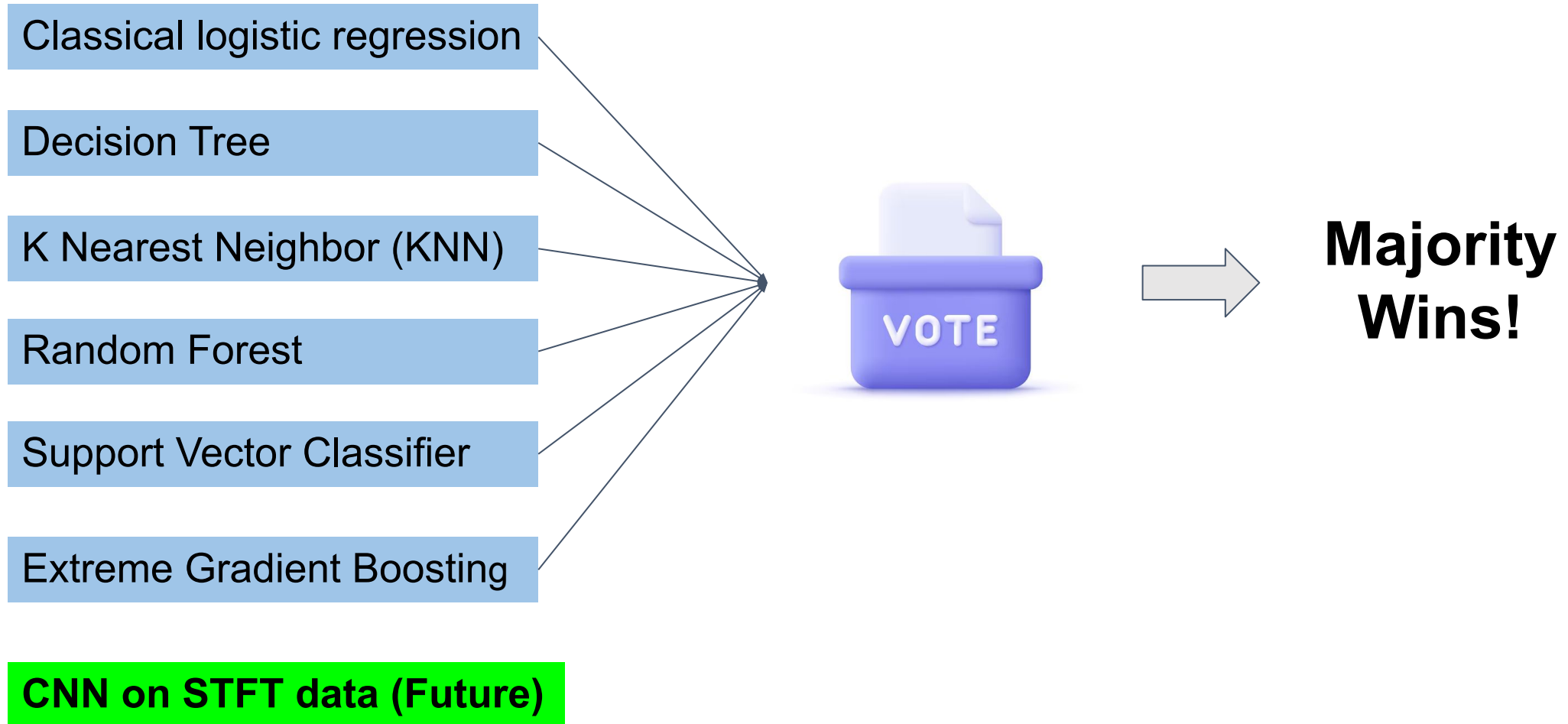


	Sex	Age	Frequency	Amplitude	Fatigue1	F1_Std	Fatigue2	F2_Std	Index
1	F	71	1.83	39270.76	-9.24	8296.63	-0.01322	0.032329	3
2	M	72	3.3	12025.1	8.89	2344.22	0.0086	0.005803	1
3	F	7	3.91	7528.59	8.98	5330.89	-0.00487	0.014482	1
4	M	47	2.11	10023.46	11.58	2260.96	-0.0061	0.004794	2
5	M	50	4.5	17453.73	2.72	2498.19	0.002223	0.003064	1
6	F	45	2.31	27188.87	3.27	1423.53	-0.00753	0.021626	2
7	M	17	3.2	13014.72	1.81	568.57	-0.00892	0.011615	1
20	F	76	2.91	19439.62	-1.57	607.57	0.016341	0.007624	1

CLASSIFIER MODEL



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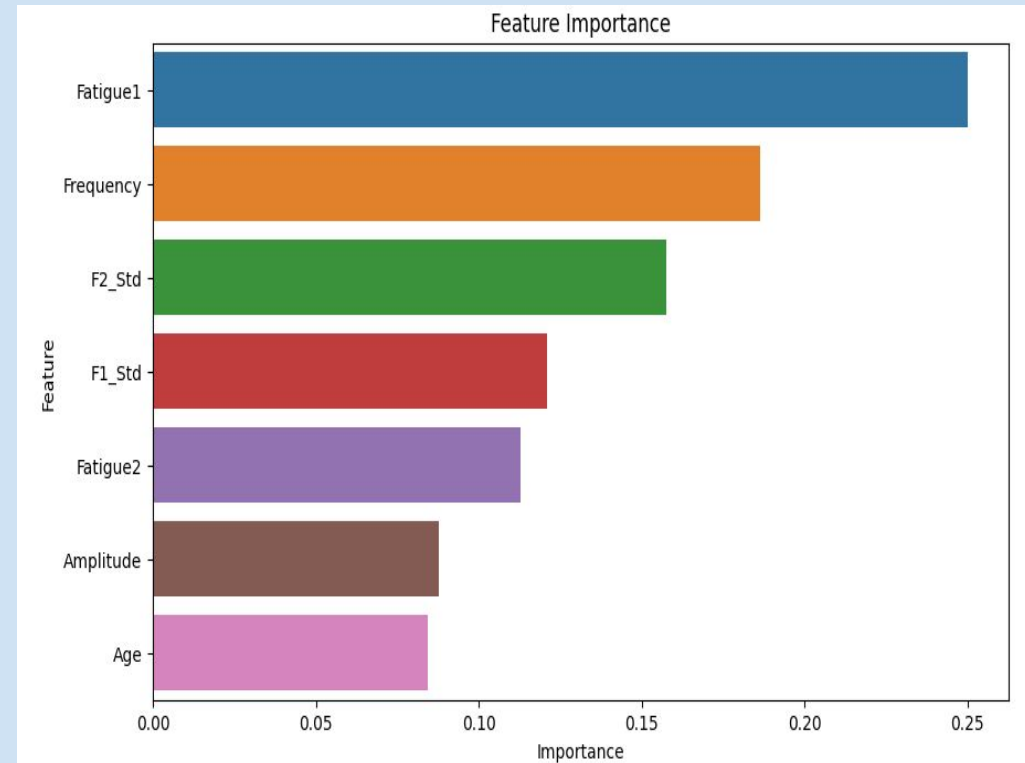
FEATURE WEIGHTING



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Our Model indicates:

- Amplitude trend of FAM (Fatigue 1) as well as resting tremor frequency are the 2 dominating weighting features to accurately predict the severeness of PD



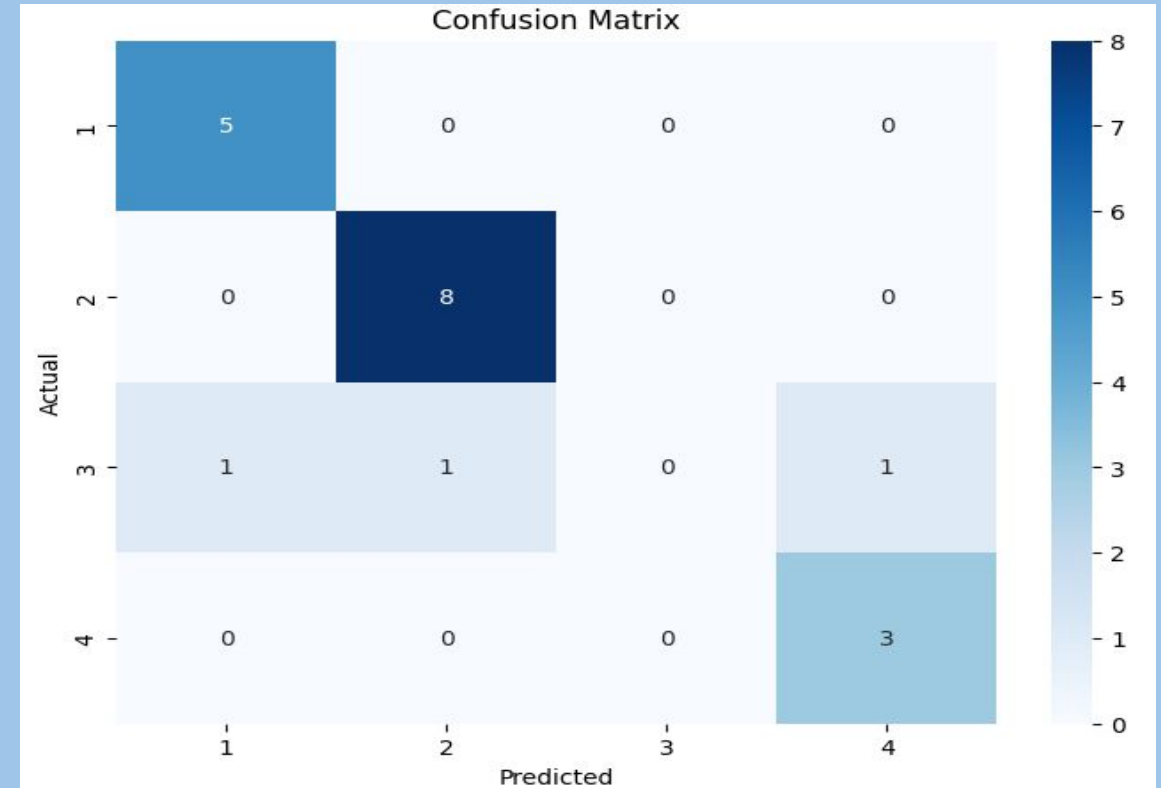
Weighted feature after AI training

MODEL ACCURACY



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- ❖ Confusion Matrix for the 19 validation datasets
- ❖ 84.2% accuracy
- ❖ Accuracy can be further improved with more training Data
- ❖ Current model is susceptible with the overfitting issue due to limited field data



Our model predicts with an **84.2%** accuracy

SUMMARY

- ❖ Feasibility of developing at-home based monitoring system
- ❖ This system enables remote diagnosis and continuous monitoring, providing healthcare providers with real-time data and insights into the progression of the disease.
- ❖ This timely information is crucial for early intervention and potentially life-saving treatments.

FUTURE WORK

- ❖ Refining and enhancing the system's capabilities
- ❖ More advanced hand tremor model
- ❖ Collecting additional certified data

By continuously refining and expanding our technology, we aim to revolutionize the care of individuals with neurodegenerative diseases, improving their quality of life and overall health outcomes.

ACKNOWLEDGEMENT



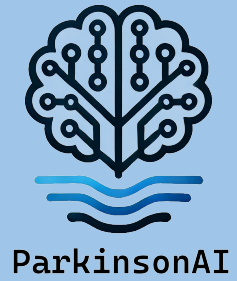
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Wenzhen Duan, M.D., Ph.D

- ❖ 20 year + experience on Neurodegenerative Disease
- ❖ Prof. of Psychiatry and Behavioral Sciences, Neuroscience
- ❖ **School of Medicine, Johns Hopkins University**

Huaibin Cai, Ph.D

- ❖ 25 year + experience on Parkinson's Disease
- ❖ Deputy Chief of Laboratory of Neurogenetics
- ❖ **National Institutes of Health**



Thank you

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