

Interactive Visualization of Parkinson's Disease Walking Data

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Introduction

- The DigiPsych Lab works on various projects that use predictive ML models to identify diagnostic features that change with medication.
- Pittman et al (2019) used walking data from a cell phone app to predict if a patient has Parkinson's or not.
- Currently, they are working on using walking data to predict medication status.



Parkinson's Disease (PD)

- PD is a neuro-degenerative disease that affects movement.
- PD cannot be diagnosed via blood test or scan, and has no known cure.
- The four classic symptoms of the disease are tremors, rigidity in the wrist and elbow joints, lack or slowness of movement, and an unstable posture.
- Current treatment options are limited and can only slow the progression of the disease.

The mPower Project

1. Walking data is collected from patients through the **Sage Bionetworks mPower app**. Raw data is generally **sinusoidal (wave-like)** in nature due to natural walking movements.

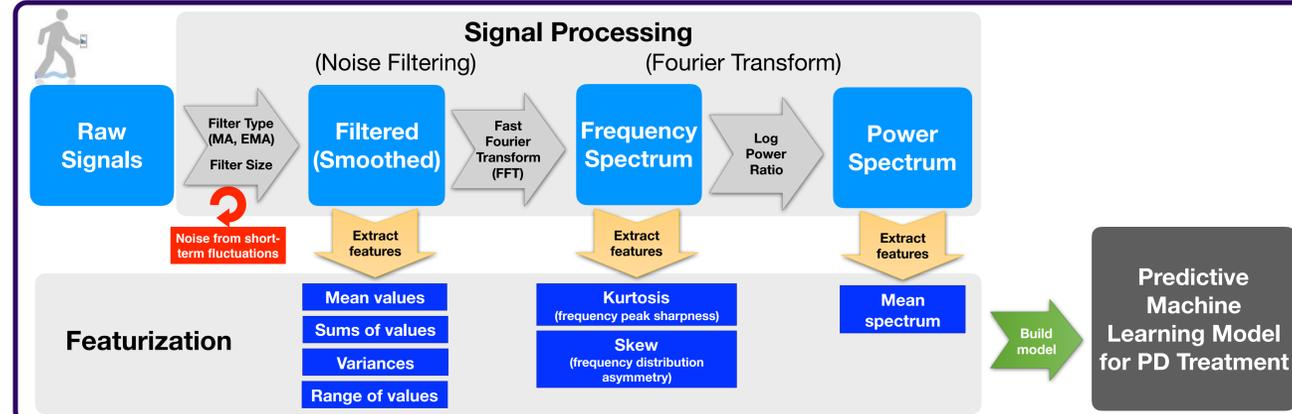


2. Waveforms are processed using various methods, such as **smoothing** and **Fourier transforms**, in order to reduce data into simpler representations for comparison.

Reduced motor coordination will produce irregular waveforms in walking data. Medication for PD drastically improves patient condition. **We hypothesize that the waveforms produced by PD patients after ingesting medication will differ measurably from waveforms produced prior to medication.**

Visualization Design

FLOWCHART



Signal Processing

1 Preprocessing

1. Choose a type of smoothing (low pass) filter to process the time series

2. Choose the size of your filter. Short-term averages respond quickly to changes while long-term averages are slow to react

3. Check out your resulting line chart

Moving Average helps smooth out the data by filtering out the noise from random short-term fluctuations.

Exponential Moving Average is a weighted moving average that gives more importance to recent data.

4. Apply Fast Fourier Transform to data

Apply a Fourier transform to filtered walking data to transform time series data into characteristic frequency signatures

5. Compute the power spectral density spectrum

After taking the Fourier transform, compute the power spectral density spectrum of the transformed data to reveal the characteristic power distribution of the waves.

GOAL

Visualize the effect of various **signal processing steps** on the raw time-series data used to train the ML model.

This will determine which methods best preserve meaningful features in the data and show more informative plots.

Increasing the **filter size** smooths some higher-frequency signals in the Fourier transformed spectra; this is likely due to suppression of baseline noise, but can also represent suppression of real signals.

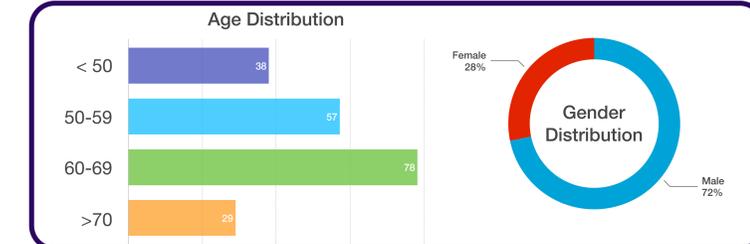
Similarly, the effects of **filter size** on the power spectrum can be explored.

Acknowledgments

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Featurization

DEMOGRAPHICS



VISUALIZATION OF FEATURES

GOAL

Allow users to explore the correlation between features and various demographics filters (gender, age, and smartphone proficiency), for two categories:

- For patients who have not yet taken medication;
- For patients who have just taken medication.

Conclusions

- Most feature distributions appear very similar for the two categories of medication status
- Demographic variables such as age and gender generally do not improve separation of features for the two categories of medication status
- Potential cause: Signal processing leads to loss of useful information which could predict medication status. Indeed, when we change how the accelerometer and device motion data are averaged, there are large-scale changes to the power spectrum which is used to derive the features.

References

Pittman, Benjamin, Reza Hosseini Ghomi, and Dong Si. "Parkinson's Disease Classification of mPower Walking Activity Participants." *2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*. IEEE, 2018.