Introduction

- Parkinson’s disease (PD) is a neurological disorder affecting the motor system that results from the loss of cells in the substantia nigra, the area of the brain that produces dopamine (Parkinson’s Diagnosis). One symptom of PD is speech impairment, which can be characterized by quiet speech, breathlessness, slurring, mumbling, monotone voice, extremely rapid speech, and/or speech delay (Downward).

- No specific tests exist for diagnosing PD, so it can only be detected through symptoms (Parkinson’s Diagnosis). As a result, studies have investigated the possibility of determining PD through the analysis of speech phonation data with machine algorithms, such as Support Vector Machine (SVM) (Little; Tsanas).

- This study aims to use machine learning algorithms and speech examination data to diagnose PD. Greater clarity in classifying PD can lead to higher accuracy in detection and reduce uncertainty.

After training and testing each of the five algorithms and recording the accuracy of each in its ability to detect PD, it was clear that the deep learning algorithm was most reliable.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Layer Perceptron</td>
<td>0.38</td>
</tr>
<tr>
<td>K Nearest Neighbor</td>
<td>0.45</td>
</tr>
<tr>
<td>Support Vector Machine</td>
<td>0.47</td>
</tr>
<tr>
<td>Stochastic Gradient Descent</td>
<td>0.52</td>
</tr>
<tr>
<td>Deep Neural Network</td>
<td>0.93</td>
</tr>
</tbody>
</table>

Table 1. Diagnosis Accuracy Per Algorithm. The above table shows the test accuracy of each algorithm for determining PD.

While the Single Layer Perceptron only produced a 38% accuracy (slightly better than random guessing), the Deep Neural Network performed exceedingly well with 93% accuracy.

Discussion/Conclusions

The heatmap demonstrates that there are some correlations between speech features. This confirms that there are patterns through which machine learning algorithms, in particular DNN, can reliably classify patients with PD.

There are a few possible reasons why the other four algorithms had low accuracy. Single layer Perceptron is a relatively primitive algorithm. KNN is a “lazy” learning algorithm, and does not train to optimize classification. SVM may need normalization of the dataset before analysis, which was not done in this case. Finally, SGD does not optimize the loss function, so it may not have reported its accuracy correctly.

In the future, we hope to improve these algorithms for greater accuracy and continue to study methods of detection for Parkinson’s Disease.

Methods

- The dataset used is from the journal “Automated analysis of connected speech reveals early biomarkers of Parkinson’s disease in patients with rapid eye movement sleep behaviour disorder” (Hlavnička). This dataset contains speech examination results of 130 subjects: 30 newly diagnosed and untreated Parkinson’s patients, 50 healthy control subjects, and 50 REM Behavior Disorder (RBD) patients. RBD is a sleep disorder that causes a high risk of PD. 12 speech features were recorded, including rate of speech timing, duration of pause intervals, and relative loudness of respiration.

- Machine learning algorithms were implemented to find the most accurate solution. A single layer Perceptron, K Nearest Neighbor (KNN), Support Vector Machine (SVM), Stochastic Gradient Descent (SGD), and Deep Neural Network (DNN) were each trained and tested using the dataset. Each algorithm, with the exception of DNN, was trained and tested 100 times, and an average accuracy recorded. The algorithms, except DNN, were programmed in Python using the scikit-learn library. DNN, on the other hand, was programmed in Python using the TensorFlow open source machine learning framework.

References


Acknowledgements

Special thanks to Marija Stejanova for her assistance as well as to the BU RISE Practicum program for this opportunity. This project would not have been possible without support from Oufen Zhao, Tiesong Ma, Xiao Fang, and Lijun Yin.