Classification of Parkinson's disease patients through voice parameters collected by mobile devices

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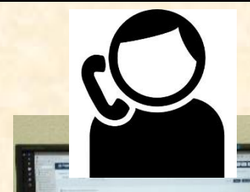
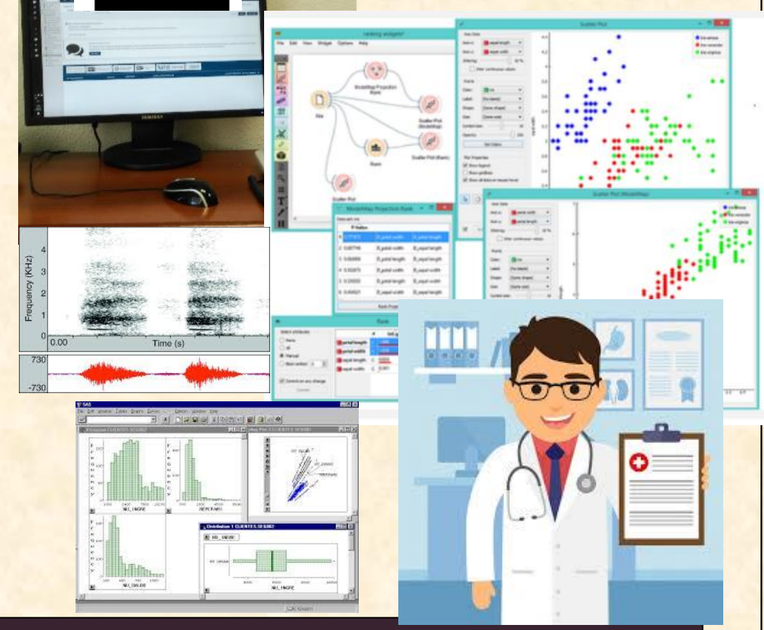
ABSTRACT

The mPower: Mobile Parkinson Disease Study is an observational study developed to evaluate the feasibility of remotely collecting information about Parkinson´s disease (PD) symptoms. With the mPower App, voice recordings have been collected by volunteer participants with their own smartphones, which was then added to each individual PD diagnosis. In this paper we present a basic analysis of the voice data and a feature extraction process on a sample of 2218 participants. Statistical analysis was performed to identify diagnosis through such parameters and some demographical variables. Principal component analysis (PCA), analysis of variance (ANOVA), and multilayer perceptron (MLP) were used in order to build a prediction model. The 62 initial parameters were reduced to 5, obtaining similar predictive capacity with 62 or 5 parameters. The use of acoustic voice parameters has been proposed as an objective and non-invasive method for the early diagnosis of the disease. This work contributes to identify voice parameters that allow, through prediction models, remote monitoring of patients, reducing costs and



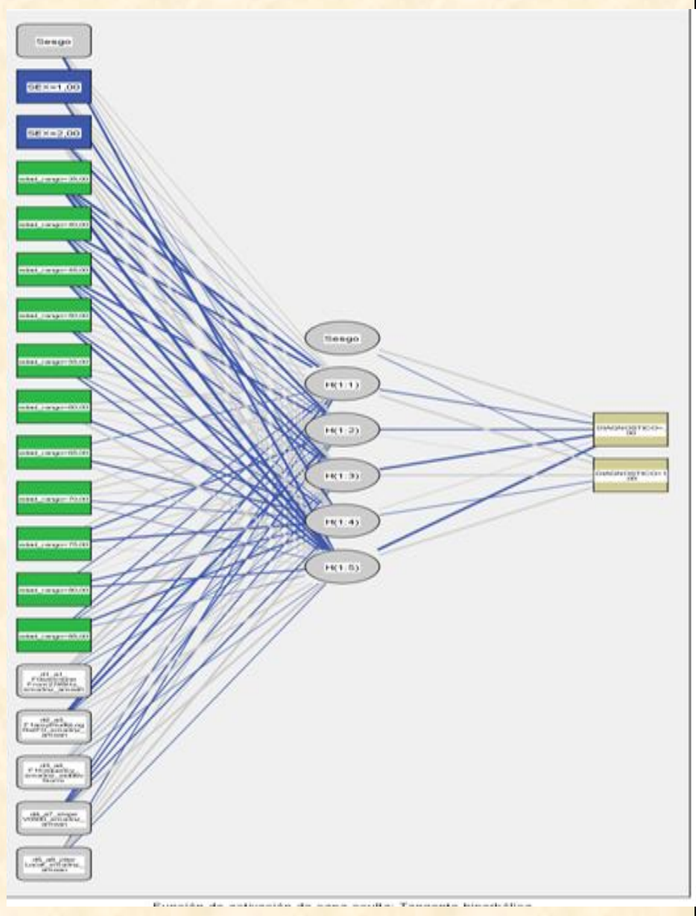
mPower **Challenge**
www.synapse.org



METHODS

The data. Coded study data, consisting of survey responses and mobile sensor measurements, were stored in Synapse for controlled distribution to researchers. From the data base available in the mPower-Synapse platform. These features were attached to other data: age, gender, PD diagnosis (true/false), years since diagnosis, years of medication. A total of people over 35 years of age were identified. For each, a recording of the phonation of the vowel /a/ was selected. PD diagnosis (true/false) was regarded as a classification variable. Then, cases with inconsistences were eliminated resulting in 2222 cases, 933 PD and 1289 non-PD.

Statistical methods. Parametrization of each recording was performed in 62 linear features using OpenSmile software. Statistical analyses with **R** were performed to identify the relevant variables that predict PD diagnosis through these parameters and some demographic variables. For such purpose, the following techniques were used: Principal Component Analysis (PCA), Analysis of Variance (ANOVA) and neural networks Multilayer Perceptron (MLP). To check the performance of the classification model, the Area Under the Receiver Operating Characteristic (AUC-ROC) Curve was used. Such method measures discrimination, that is, the ability of the test to correctly classify those with and without the disease. In addition, accuracy was calculated for each model, with a cut value 0.5, to give the percentage of well-predicted cases.



RESULTS

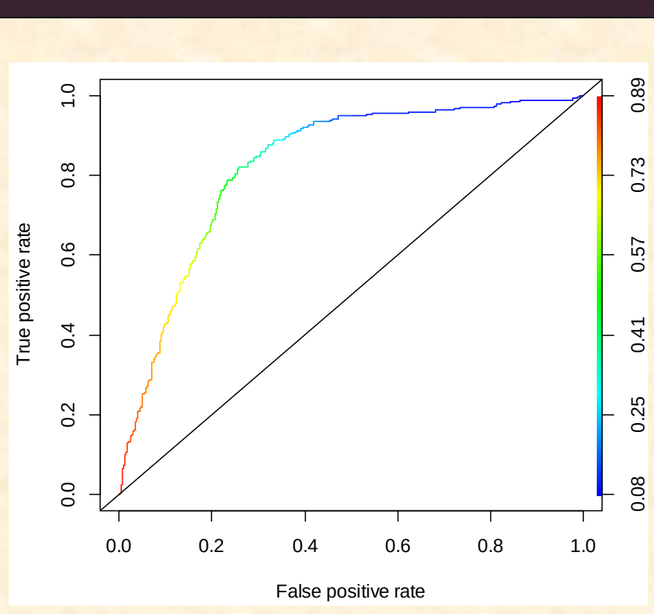
We used open software R (www.r-project.org) to build models. It was used for training and testing experiments. The sample was separated in 70% training and 30% testing data.

A two-layer MLP network is a fully-connected feed-forward neural network consisting of an input layer, a hidden layer, and an output layer (PD or non-PD).

AUC-ROC AREA ACCORDING TO THE NUMBER OF VARIABLES ANALYZED IN NEURAL NETWORKS.

Number of voice variables /parameters	Neural network. AUC
62	0.666
33	0.687
9	0.673
5	0.681

d1: Mean of logarithmic F0 on a semitone frequency scale.
d2: Mean of the ratio of the energy of the spectral harmonic peak at the first formant's center frequency to the energy of the spectral peak at F0 in voiced regions
d3: Coefficient of variation of the ratio of the energy of the spectral harmonic peak at the first formant's center frequency to the energy of the spectral peak at F0 in voiced regions
d4: Mean of linear regression slope of the logarithmic power spectrum within 0–500 Hz band entropy.
d5: Mean Jitter of the deviations in individual consecutive F0 period lengths.



The ROC curve for MLP model with 5 voice parameters, in addition to age and gender is observed in Fig. The area under that curve is AUC = 0.826. ACCURACY= 0.768 (cut value=0.5).

CONCLUSIONS

The contribution of this work lies in the selection of five simple-to-measure linear parameters of the voice from the free software OpenSMILE. Besides feature selection, the study analyzed the statistical relevance of individuals´ age and gender. With the mPower App, voice recordings were collected by volunteer participants with their own Smartphone, and this data were then added to the prediction model of PD diagnosis. Mobile phone recordings both allow for monitoring of Parkinson's patients at a low cost and detection of alterations that require attendance to the medical consultation.

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