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Poster

SUPERVISED MACHINE LEARNING MODELS FOR AUTOMATIC DETECTION OF MULTIPLE SCLEROSIS THROUGH ACOUSTIC ANALYSIS OF THE VOICE

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Abstract

Multiple sclerosis (MS) is an autoimmune and neurodegenerative disease of the central nervous system of unknown etiology and is considered the most common cause of non-traumatic disability in young adults. Early detection of this disease is challenging due to the wide variety of symptoms. Voice biomarkers are particularly relevant to research and clinical practice because they provide objective, naturalistic information about motor function in neurodegenerative diseases such as MS.

The objective of this study was to examine supervised machine learning algorithms that facilitate the automated detection of MS through the analysis of acoustic parameters of the voice.

Two hundred people with a mean age of 47.1 years (SD=12.24) without organic voice disorders were included in the study, 120 diagnosed with MS (pwMS) and 80 neurologically healthy (pNH). Both groups were gender-balanced (⊠2=1.97, p=0.159). Each participant recorded a four-second sustained vowel with the Praat and 15 acoustic parameters were obtained using the Voxplot program. The sample was divided into 80% for training and 20% for testing. To identify the most relevant acoustic parameters for machine learning (ML) models, an elastic net model was applied. A 10-fold cross-validation on the training sample was used to obtain the best alpha and lambda that were then used in the test set was performed to determine optimal alpha and lambda values, which were then applied to testing set to select the final set of acoustic variables. Subsequently, the selected variables were used to train ML models, including Random Forest (RF), Decision Tree (DT), K-Nearest Neighbors (KNN), Support Vector Machines (SVM) and eXtreme Gradient Boosting (XGB). To evaluate the robustness of the results, a simulated sample was generated from the original data using the mvrnorm function from the MASS package, and the same procedure was repeated. A balanced sample of 510 (255 pwMS and 255 pHS) was obtained according to the prevalence of the disease in the Canary Islands (255 per 100,000 inhabitants).

In the real sample, the RF model demonstrated the highest level of accuracy (accurate=0.82, sensibility=0.81, specificity=0.84, ROC-AUC= 0.84). The SVM and XGB models also demonstrated satisfactory performance, exhibiting an acceptable level of accuracy and balanced sensitivity and specificity. Conversely, the DT and KNN models exhibited high sensitivity but very low specificity. In the simulated sample, the RF and XGB models demonstrated significant enhancement with perfect sensitivity (accuracy=0.99, sensibility= 1, specificity=0.98, ROC-AUC=1, in both models). The SVM model demonstrated an enhancement in its performance, while the DT and KNN models exhibited an increase in specificity, accompanied by a decrease in sensitivity. The results indicate that increasing sample size improves the performance of bagging and boosting models.

Acoustic voice analysis is a technique that can detect minimal alterations in motor function. The use of ML

methodologies, such as RF (or XGB when the data set is sufficiently large), allows high levels of diagnostic accuracy to be achieved.

Keywords

machine learning, voice, multiple sclerosis

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