Improving diagnostic accuracy: development of an artificial intelligence model to aid in the diagnosis of Alzheimer's disease dementia.

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Early diagnosis of Alzheimer's disease is crucial to improve patient outcomes. Using the CRIPS-DM methodology, an IA model was developed that achieved high accuracy in diagnosing Alzheimer's. This model reduces the need for extensive neuropsychological testing, making it a cost-effective tool for health professionals. However, it's currently adapted to the population of Medellin, Colombia, and requires further validation for wider use. This tool has the potential to significantly improve Alzheimer´s diagnosis and support clinical decision making.

INTRODUCTION

Background

Alzheimer's Disease Dementia (ADD) is a neuropsychiatric disorder that significantly and progressively impairs cognitive domains, primarily affecting memory, language and visuospatial skills. ADD accounts for 60% to 70% of dementia cases globally and its prevalence in people older than 60 years old equals 4.02%.

Rationale

Although several organizations like the World Health Organization, the American Psychiatric Association and the National Institute on Aging and the Alzheimer's Association establish clear and precise criteria for ADD, there are several factors that hinder their application such as the clinical heterogeneity of ADD, its similarities with other neurodegenerative diseases and the presence of comorbidites, as well as the costs and resources (neuroimaging and genetic testing) needed to establish a differential diagnosis, especially in developing countries such as Colombia.

Objective

Develop a computerized diagnostic tool based on Artificial Intelligence (AI) to strengthen the capacity of healthcare professionals during the diagnosis of ADD.

METHODS

CRISP-DM methodology

1. Project understanding:
   - Mining objective
   - Type of analysis
   - Type of learning
   - Analytical task

2. Data understanding:
   - Data cycle
   - Data dictionary
   - Quality rules

3. Data preparation:
   - Exploratory data analysis
   - Outlier and null value cleaning
   - Correlation analysis
   - Class balancing
   - Transformations

4. Modelling:
   - Training with 70% of the data using random stratified sampling
   - Models trained: decision trees, K-nearest neighbors, neural networks, support vector machines, random forests, XGBoost and stacking.
   - Hyperparameter selection: cross validation using genetic algorithms.

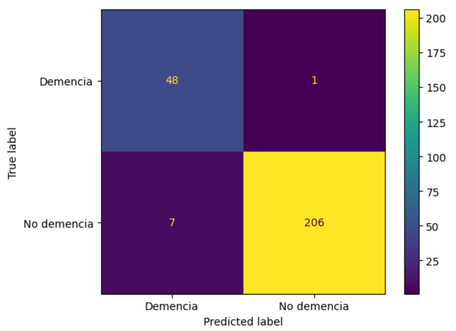
5. Evaluation
   - Metrics used: sensitivity, specificity, f1 score, AUC-ROC, balanced accuracy.

6. Deployment
   - UI design to use the model in a real world setting.

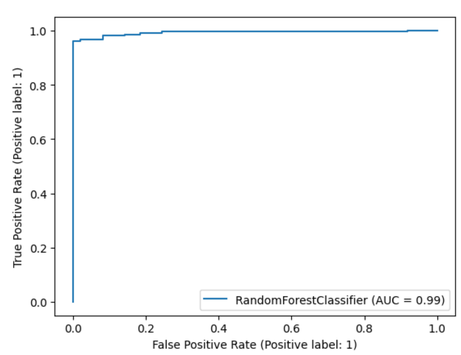
RESULTS

A total of 147 ML models were trained to classify people with and without ADD. Using a random forest (RF) algorithm and 33 features we achieved a sensitivity of 98%, a specificity of 100% and an area under the receiver operating characteristic curve (AUC-ROC) of 0,988.

Confusion matrix of the model with the best performance



ROC of the model with the best performance



CONCLUSIONS

Discussion

We trained and evaluated a variety of ML models, highlighting the accuracy of a RF algorithm together with the use of GAs, to distinguish people with and without ADD. Among the 33 variables used are the results of the following neuropsychological tests: The Lawton Instrumental Activities of Daily Living Scale, Clinical Dementia Rating, Fast, Barthel, KATZ, MMSE, EDG, MLP, NPI, ROCF, TMT, FAS and Raven. We deployed the model with the best performance metrics through a graphical user interface in order to promote its future use in clinical settings. Although these results are promising, the ongoing need to evaluate and re-train the model, as well as the ethical considerations of its implementation.

Limitations

Since our model only takes into account sociodemographic data, medical records and neuropsychological tests results, its predictions are only valid from a symptomatic standpoint and don't replace the need for neuroimaging or genetic testing in order to provide a differential diagnosis of ADD. Furthermore, our model is based towards the population included in this research: 870 patients from Medellin, Colombia. Therefore, due to the influence of social, cultural and environmental factors over the clinical presentation of ADD, the model is not intended to be used in other countries or even in Colombian regions which vary significantly from Medellin.

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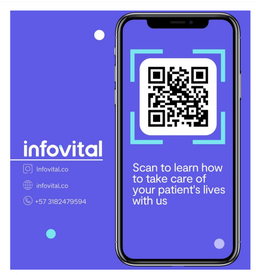
CONTACT



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