Detecting Parkinson's Disease using Machine Learning

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OBJECTIVE

- To use Machine Learning techniques to identify the presence of Parkinson's disease in people by analyzing their motor skills via hand-drawn patterns
- To enable early prediction and proper treatments which can possibly stop or slow progression of Parkinson's disease to end stage
- To collaborate with health care sector and generate revenue from their customers

Machine Learning for the Diagnosis of Parkinson's Disease: A Review of Literature

www.frontiersin.org/articles/10.3389/fnagi.2021.633752/full

This article is a summarization of many different approaches to the detection of Parkinson's disease. The article tells us how they have searched for papers in PubMed and IEEE and also how the data has been collected in the studies. It tells us the study objective which is: (a) the diagnosis or detection of PD (which compares data collected from PD patients and healthy controls), (b) differential diagnosis (discrimination between patients with idiopathic PD and patients with atypical Parkinsonism), and (c) sub-typing (discrimination among sub-types of PD).It tells us about how these models are evaluated and what the comparison metric is for models in a single study. It also tells us how many subjects were there in each study and if they were actual human data or from online datasets.

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The article tells us how they divided 448 machine learning models from the 209 studies into 8 categories: (1) support vector machine (SVM) and variants (*n* = 132 from 130 studies), (2) neural networks (*n* = 76 from 62 studies), (3) ensemble learning (*n* = 82 from 57 studies), (4) nearest neighbor and variants (*n* = 33 from 33 studies), (5) regression (*n* = 31 from 31 studies), (6) decision tree (*n* = 28 from 27 studies), (7) naïve Bayes (*n* = 26, from 26 studies), and (8) discriminant analysis (*n* = 12 from 12 studies). A small percentage of models used did not fall into any of the categories (*n* = 28, used in 24 studies). On average, 2.14 machine learning models per study were applied to the diagnosis of PD. Various metrics have been used to assess the performance of machine learning models. The most common metric was accuracy (*n* = 174, 83.3%), which was used individually (*n* = 55) or in combination with other metrics (*n* = 119) in model evaluation. Among the 174 studies that used accuracy, some have combined accuracy with sensitivity (i.e., recall) and specificity (*n* = 42), or with sensitivity, specificity and AUC (*n* = 16), or with recall, precision and F1 score (*n* = 7).. A total of 35 studies (16.7%) used metrics other than accuracy. In these studies, the most used performance metrics were AUC (*n* = 19), sensitivity (*n* = 17), and specificity (*n* = 14), and the three were often applied together (*n* = 9) with or without other metrics.

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The article also tells us about the different data types and outcomes that have been used in these studies and explains how machine learning has been used for each of them. Out of 209 studies, 122 (58.4%) applied machine learning methods to movement-related data, i.e., voice recordings (n = 55, 26.3%), movement data (n = 51, 24.4%), or handwritten patterns (n = 16, 7.7%). Imaging modalities analyzed including MRI (n = 36, 17.2%), SPECT (n = 14, 6.7%), and positron emission tomography (PET; n = 4, 1.9%). Five studies analyzed CSF samples (2.4%). In 18 studies (8.6%), a combination of different types of data was used. It also gives us an overall summary of the Principal Findings and Limitations of this particular study that they have carried out.

Reliable Parkinson's Disease Detection by Analyzing Handwritten Drawings

https://ieeexplore.ieee.org/document/8781770

Parkinson's disease (PD) is the second most common neurodegenerative disease of central nervous system (CNS). Till now, there is no definitive clinical examination that can diagnose a PD patient. However, it has been reported that PD patients face deterioration in handwriting. Hence, different computer vision and machine learning researchers have proposed micrography and computer vision based methods.. To improve the PD detection accuracy, a cascaded learning system that cascades a Chi2 model with adaptive boosting (Adaboost) model is proposed. The Chi2 model ranks and selects a subset of relevant features from the feature space while Adaboost model is used to predict PD based on the subset of features. Experimental results confirm that the proposed cascaded system shows better performance than other six similar cascaded systems that used six different state of the art machine learning models. Moreover, it was also observed that the proposed cascaded system improves the strength of conventional Adaboost model by 3.3% and reduces its complexity. Additionally, the cascaded system achieved classification accuracy of 76.44%, sensitivity of 70.94% and specificity of 81.94%.

High-accuracy detection of early Parkinson's Disease using finger movement

https://pubmed.ncbi.nlm.nih.gov/29190695/

Parkinson's Disease (PD) is a progressive neurodegenerative movement disease affecting over 6 million people worldwide. Loss of dopamine-producing neurons results in a range of both motor and non-motor symptoms, however there is currently no definitive test for PD by non-specialist clinicians, especially in the early disease stages where the symptoms may be subtle and poorly characterised. This results in a high misdiagnosis rate (up to 25% by non-specialists) and people can have the disease for many years before diagnosis. A novel methodology was used to classify the subjects' disease status, by utilising a combination of many keystroke features which were analysed by an ensemble of machine learning classification models. When applied to two separate participant groups, this approach was able to successfully discriminate between early-PD subjects and controls with 96% sensitivity, 97% specificity and an AUC of 0.98. The technique does not require any specialised equipment or medical supervision, and does not rely on the experience and skill of the practitioner. Regarding more general application, it currently does not incorporate a second cardinal disease symptom, so may not differentiate PD from similar movement-related disorders.

A Deep Learning-CNN Based System for Medical Diagnosis: An Application on Parkinson's Disease Handwriting Drawings

https://ieeexplore.ieee.org/document/8751879

Parkinson's disease (PD) is a degenerative disease that affects the motor system, which may cause slowness of the speech and the movements, and the anomaly of writing abilities due to tremor. PD diagnosis by Deep Learning approach has become an important worldwide medical issue through the last years. It is obvious that these patients due to their physical conditions are not suitable for every kind of PD diagnosis test. One of the non-invasive PD identification methods is the handwriting test, which is utilized in hospitals since many years ago. In this work we propose Convolutional Neural Network (CNN) based Deep Learning system to learn features from Handwriting drawing spirals which are drawn by People with Parkinson; also, we evaluated the performance of our deep learning model by K-Fold cross validation and Leave-one-out cross validation (LOOCV) techniques. Moreover, we introduce a dataset with a novel test which is called Dynamic Spiral Test (DST) along with traditional Static Spiral Test (SST) for PD recognition. We used both dynamic features and visual attributes of spirals. The proposed approach was reached to 88% accuracy value. The analysis of handwritten drawing tests proves that it is useful to combine SST and DST tests for automatic PD identification.

A Step Towards the Automated Diagnosis of Parkinson's Disease: Analyzing Handwriting Movements

https://ieeexplore.ieee.org/document/7167480

Parkinson's disease (PD) has affected millions of people world-wide, being its major problem the loss of movements and, consequently, the ability of working and locomotion. Although we can find several works that attempt at dealing with this problem out there, most of them make use of datasets composed by a few subjects only. In this work, we present some results toward the automated diagnosis of PD by means of computer vision-based techniques in a dataset composed by dozens of patients, which is one of the main contributions of this work. The dataset is part of a joint research project that aims at extracting both visual and signal-based information from healthy and PD patients in order to go forward the early diagnosis of PD patients. The dataset is composed by handwriting clinical exams that are analyzed by means of image processing and machine learning techniques, being the preliminary results encouraging and promising. Additionally, a new quantitative feature to measure the amount of tremor of an individual's handwritten trace called Mean Relative Tremor is also presented.

Parkinson's Disease: Pathogenesis and Clinical Aspects

www.ncbi.nlm.nih.gov/books/NBK536722/

Parkinson's disease (PD) is a common neurodegenerative disorder. While a number of non-motor manifestations arise, the typical clinical features involve a movement disorder consisting of bradykinesia, resting tremor, and rigidity, with postural instability occurring at a later stage. The cause of PD is not known, but a number of genetic risk factors have now been characterized, as well as several genes which cause rare familial forms of PD. Environmental influences such as smoking, caffeine consumption, and pesticide exposure have been postulated to alter the risk of PD development, although the role of these remains unclear. The movement disorder arises due to the loss of dopaminergic neurons of the substantia nigra pars compacta, with the pathological hallmark being intracellular aggregates of α-synuclein, in the form of Lewy bodies and Lewy neurites. Several processes have been implicated in PD, including mitochondrial dysfunction, defective protein clearance mechanisms, and neuroinflammation, but the way in which these factors interact remains incompletely understood

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THANK YOU!