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Artificial Intelligence: A Breakthrough for Neuroscience

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Abstract: ***"Healthcare is yet to be transformed by Technology", this saying by Joshua Kushner holds so true for what we are witnessing today. After the intervention of Artificial Intelligence we can identify, scrutinize, decipher and in some cases even predict Neurodegenerative Disorders before they become terminal. Neurodegenerative disorders, are almost incurable state resulting in deterioration and eventually death of the nerve cells. Parkinson's, Alzheimer's and Huntington's disease are major Neurodegenerative disorders affecting around one billion people in the world. These neurodegenerative disorders can bring about problems ranging from extrapyramidal symptoms, sleeplessness, depression, constipation etc. They may also result in weariness, twinge, olfactory dysfunction, blood pressure fluctuations etc. This paper aims to provide a solution by using machine learning and reinforcement learning techniques. By collecting relevant data over the course of a few weeks, a model could be built to identify and predict the category, intensity and frequency by utilizing the power of Two-Class Boosted Decision Tree and Fast Forest Quantile Regression. These Machine Learning algorithms shall be used for an initial learning phase, fed by data taken from volunteer subjects through portable hand-held electronic devices that will be responsible for monitoring and sending research related data by extracting brain waves and sending them to a central Data Warehouse for further processing. After the initial training, the paper is hoping to provide way for improvement through reinforcement learning. A system loaded with previous models shall improve itself by learning from the interaction (new data) with its surroundings, increasing the accuracy of our predictions. By identifying precursor signs of such a disorder, a doctor might be able to devise a solution that may prevent it from happening in the first place. Neuroscience has already been facilitated by Artificial Intelligence but here we are trying to move an inch forward with discussing the concept of working method of prospective undersized, portable tech gadgets to assist research and treatment.***

Keywords: Neurodegenerative Disorder, Artificial Intelligence, Deep learning

1. Introduction

The point at which whole medical science is standing today, it'll be correct to say that this has been achieved by the convergence of many other fields, but the most important companion here is Technology. Today, every aspect of our life is absolutely preoccupied with machinery, robotics, automation and what not!

But let us sit back and recall where, how and when did this start. So, technology in medical sciences initially came in existence by the early Egyptians carrying out investigations in order to cure people.

Later on, a very important name in this timeline is R. Bacon who in mid 13th century made something which could show an enlarged image of objects. After this, many scientists came forward and proposed technical equipments such as Stethoscope, glasses etc. In the second half of 19th century and early 20th century medical science came along with Physics and created techniques in order to read brain waves (Electroencephalography), heart impulses(Electrocardiography) as well as X-Ray machine.

Then, in the mid 20th century technology started to accompany medical science to take on the diseases by giving dialysis machine, correction of cataract, Magnetic Resonance Imaging etc. The period post mid 20th century has marked significantly by the innovations leading to manufacture of advanced equipments.

Even after developing this much in technological aspects, we aren't able to prevent billions of people who are being affected by numerous diseases worldwide.

Talking about Neurodegenerative disorders, their prevalence has alarmingly increased over the time. They affect more than one billion people in the world now and are pretty incurable even after us having extraordinarily designed equipments for treatment purposes.

In present scenario, we can see that the latest big thing making a huge difference in numerous fields is Artificial Intelligence. Here, in this paper we have tried to introduce the applications of A.I. in the field of Neurodegenerative disorders, showing how A.I. can facilitate their research, early diagnosis, prevention, assessment as well as treatment.

Some biotech companies have came forward with machine-learning algorithms to examine brain signals. Also there've been a no. of studies on how these algorithms can be used in Neuroscience and medical science as well.

2. Literature Review

Nadine Bakkar, Tina Kovalik et al. in 2018 carried out a research on the application of A.I. in a neurodegenerative disease. The disease focused was Amyotrophic Lateral Sclerosis (ALS) in which the muscles lessen the process of functioning (which eventually worsens). IBM Watson was used to dig up every literature possible related to ALS and RBPs (RNA binding proteins).

The result was that, with the help of IBM Watson they were able to make some distinguished achievement and took the breakthrough in ALS to an another level.

Demis Hassabis, Darshan Kumaran et al. in a study in 2017 tried to explain that Biological brains will be really helpful in order to understand and create new technology. In this

study, they also threw light upon the breakthrough enhancements in the field of Artificial Intelligence which are influenced by the biological brains.

Nihal Fatma Güler et al. in a study, in 2005 examined and discriminated various EEG signals in patients of Epilepsy at their different conditions by testing the capacity of Elman RNNs (Recurrent Neural Networks). The precision of the RNNs (Recurrent Neural Networks) was found to be much more than feedforward Neural Network models which is the easiest type of Artificial Neural Network invented.

The results of the test made it clear that the Recurrent Neural Networks implementing the Lyapunov exponents are able to interpret the electrical impulses of the brain in order to diagnose changes in the electrical activities of the brain at early stage.
İnan Güler and Elif Derya Übeyli in 2005 wrote a paper regarding the relevance of Adaptive Neuro-Fuzzy Inference System (ANFIS) in order to categorize electrical impulses of the brain. The fine execution of ANFIS established that it has the ability to categorize the electrical impulses.
Umut Orhan et al. carried out a research to assess how the Multilayer Perceptron Neural Network (MLPNN) categorizes divisions related to Epileptic seizures. In their research they made Multilayer Perceptron Neural Network as a diagnostic system for Epilepsy. The results made it clear that it was proficient enough to give proper divisions.

Yüksel Özbay et al. in 2006 examined categorization of Electrocardiography signals from Multilayered Perceptron (MLP) and from Fuzzy Clustering Neural Network (FCNN) as well. It was found that the FCNN was more efficient in giving conventions than MLP.

U. Rajendra Acharya, Hamido Fujita et al. in 2017 carried out a research in which they used Convolutional Neural Networks architecture in order to keep track of electrical impulses of the heart. Usually it is very difficult to analyze the ECG impulses and that is why they came up to this innovative anticipation.

The results shown very high precision and also proved that this CNN architecture can spot and provide precise results about abnormal ECG impulses in the presence of sound too.

Serkan Kiranyaz et al. in 2016 used Convolutional Neural Networks by making an uncomplicated CNN for every person in particular which learnt about that person by instructing information. When this CNN has learnt about the person it can be used for organising and analysing of ECG impulses for longer intervals.

U. Rajendra Acharya, Hamido Fujita et al. in their investigation in 2017 used Convolutional Neural Networks algorithms for mechanized finding of Coronary Artery Disease. CNN successfully distinguished between regular and irregular ECG impulses.

It can be a futuristic approach in order to diagnose Coronary Artery Disease because of its precise results, instead of the system which is in use at present which can be imprecise.

Purpose

The purpose of this conceptual paper is to provide the concept of working method of prospective undersized, portable tech gadgets to assist research and treatment of Neurodegenerative disorders by using machine learning and reinforcement learning techniques.

Outcomes

1) This conceptual paper will help Computer Scientists and Data Scientists working on Artificial Intelligence to look into the broader applications of machine learning, reinforcement learning and everything that comes under the umbrella of Artificial Intelligence. It will make them understand the importance and further interventions of A.I. possible in the field of Neuroscience.
2) Major aspect of any disorder is its assessment, prediction and management. This concept will enable researchers and doctors to keep track of their patients for 24/7 and also to analyze the line of treatment they are following.
3) It will be a great asset to have for people who are at the onset of developing a neurodegenerative disorder or having symptoms that can lead to one.

3. Research Methodology

Our Research methodology will give a fine idea regarding how the design should be and manufacture of A.I. based conceptualized devices and equipments. These A.I. based conceptualized portable machines in future will be able to examine, interpret, analyze and perform ‘n’ number of other learnt tasks while serving the research purpose as well as during assessment and treatment period of neurodegenerative disorders.
There is a proper step by step working procedure of these conceptualized gadgets which we have stated and upon which a concrete device can be made.
Our procedure would follow steps involving:

1) Extraction of raw data from the subject using non-invasive methods for detecting and capturing brain waves. We will require a wireless EEG machine so that raw data can be sent from the patient to the server. Our server will be based on SaaS (Software as a Service) where an EEG software will convert raw data into usable and structured data. The same data will be pre-processed and prepared to be sent through a machine learning/deep learning algorithm.
2) Transformation of raw data into clean and structured data that can be pushed into our machine learning algorithms. Pre-processing of data shall require feature selection, dimensionality reduction, cleaning of redundant & noisy data by either removal or filling in using a decision tree.
3) Building (training) our machine learning model(hypothesis) for predictive analysis through that structured data. After pre-processing our data, we will be training it with about 80% of our data and testing it with rest of the 20% of our data. The process of training and testing shall continue until we achieve a desirable accuracy on our model.
4) Testing our model and improving it as we continue working on it. With the time we’ll make efforts to make our predictions more and more precise and our device more handy. This proposed solution should be able to help predict any future cases of neurological disorders

and help doctors determine them before symptoms worsen.

4. Results

For this approach to work, we would require a small enough device that can extract signals from the brain and send raw brain signals data from our subject to our servers for building/training our model and testing it.

This process of extracting data, analyzing it, drawing the reports and making predictions about the brain signals can function 24 hours a day continuously and can transmit the reports and predictions to the doctor and to a system as well to keep track of the brain activities of whole day.

This device will be very helpful in assessing the severity of the patient and with the help of machine learning model and predictive analysis this device will also be able to facilitate in deciding future line of treatment of the patient . As this device is portable, it will also be of immense help for carrying out researches on Neurodegenerative disorders on long term basis over people for getting more accurate results.

5. Conclusion

For the part where we are trying to determine if a person has neurological disorder we could build our model on the basis of a number of data points separated by an n-dimension hyper plane. We should be able to get an equation like:
w1x1 + w2x2 + w3x3 + ... wnxn - b = 0
Where w = weight, x = feature(symptom), b = bias

Answer of this equation should help us decide whether the person has that disorder or not. So, that way if the number is positive then the person has the disorder, otherwise, the person does not.

Above equation is for a very simple multi layer neural network which can also be called as a " Multi layer Perceptron"(MLP). It'll become more complex as we work further and continue working with more specialized neural network architectures, like using Convolutional Neural Networks for the classification of EEG image data.

Perceptron is like a single brain cell. Neural networks take some inputs then we multiply, then with some weight (randomly generated at first, improved later), and afterwards we add some bias. Which goes through an activation function in a neuron. A multilayer Perceptron is formed by chaining together a no. of neurons (fundamental unit of neural networks) in a single layer. These layers are stacked and connected fully to each other forming a deep neural network.

References

[1] Acharya, U. R., Fujita, H., Lih, O. S., Adam, M., Tan, J. H., & Chua, C. K. (2017). Automated detection of coronary artery disease using different durations of ECG segments with convolutional neural network. *Knowledge-Based Systems*, *132*, 62-71.

[2] Acharya, U. R., Fujita, H., Oh, S. L., Hagiwara, Y., Tan, J. H., & Adam, M. (2017). Application of deep convolutional neural network for automated detection of myocardial infarction using ECG signals. *Information Sciences*, *415*, 190-198.

[3] Bakkar, N., Kovalik, T., Lorenzini, I., Spangler, S., Lacoste, A., Sponaugle, K., ... & Bowser, R. (2018). Artificial intelligence in neurodegenerative disease research: use of IBM Watson to identify additional RNA-binding proteins altered in amyotrophic lateral sclerosis. *Acta neuropathologica*, *135*(2), 227-247.

[4] Güler, I., & Übeyli, E. D. (2005). Adaptive neuro-fuzzy inference system for classification of EEG signals using wavelet coefficients. *Journal of neuroscience methods*, *148*(2), 113-121.

[5] Güler, N. F., Übeyli, E. D., & Güler, I. (2005). Recurrent neural networks employing Lyapunov exponents for EEG signals classification. *Expert systems with applications*, *29*(3), 506-514.

[6] Hassabis, D., Kumaran, D., Summerfield, C., & Botvinick, M. (2017). Neuroscience-inspired artificial intelligence. *Neuron*, *95*(2), 245-258.

[7] Kiranyaz, S., Ince, T., & Gabbouj, M. (2016). Real-time patient-specific ECG classification by 1-D convolutional neural networks. *IEEE Transactions on Biomedical Engineering*, *63*(3), 664-675.

[8] Orhan, U., Hekim, M., & Ozer, M. (2011). EEG signals classification using the K-means clustering and a multilayer perceptron neural network model. *Expert Systems with Applications*, *38*(10), 13475-13481.

[9] Özbay, Y., Ceylan, R., & Karlik, B. (2006). A fuzzy clustering neural network architecture for classification of ECG arrhythmias. *Computers in Biology and Medicine*, *36*(4), 376-388.