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REAL- TIME MINING TECHNIQUES - LATENCY MITIGATION ALGORITHMS FOR SEIZURE DETECTION

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ABSTRACT
Speed is the name of the game in today's world. Speed of change drives our everyday's life, and hence in this ever changing and agile environment it has become critical for systems to extract useful information in real time. Techniques used in sifting through streaming data to evaluate and extract useful information are called real time data analytics. The ability of these techniques to paint the picture of the changes as and when they happen makes them a vital tool in analysis and visualization of medical data especially of the neurological nature as it is very dynamic. The fact that all the evaluation and analysis needs to be done on the go make the challenges enormous. However, this very challenge if successfully met can be used to analyze neurological data related to disorders such as epilepsy, Alzheimer's, strokes and even headaches. According to WHO these ailments affects close to I billion people worldwide. However it is extremely difficult for human analysts to collate, evaluate, manage and assimilate large volumes of data related to such alements. This is where real time data analytic can step in to meet the challenges. Already we have CAD (Computer-Aided Diagnosis) that automatically detects neurological abnormalities like seizures using medical big data. The next big step will be to bring in real time analytics that have computational algorithms with the capability of predicting periods of high seizure probability with reliability with minimum latency. This not only helps patients from enjoying life threatening activities during such periods, but would also regulate medication to be used only during high seizure probability windows. This paper attempts to highlight a big data processing framework under the cloud computing platform for real time seizure prediction with the minimum of time delays.

Keywords: *Real-Time Big data analytics; Mining Techniques; Epileptic Seizures; Cloud computing; Stream processing; Detection and Prediction*

1. INTRODUCTION

The use of mobile phone applications, emails, video and audio streams health information social networks etc have contributed to explosive day to day increase in data generation. It is estimated that the daily increase in data is close to 5 Exabyte. This huge amount of data is known as big data and the process of sieving through this mountain of data to extract the useful bits is known as big data mining. From the research point of view the major challenge remains in processing this data in real time. Cloud computing at the highest level of its performance remains one of the most widely used tools for large scale data processing in real time. Any algorithm that aims at processing this type of data faces the challenges posed by the dynamic nature and the speed of change of this data stream. Not only does the algorithm attempting to process this data need deal with its dynamic nature it will also need to handle the handicaps imposed by the limitations of time and memory.

A symbiotic relationship exists between the three main areas of interest in data mining- accuracy, memory and time. They influence each other. The shorter the time the lesser the accuracy. The larger the memory better the accuracy. Currently, neurological diseases are diagnosed by using various medical techniques such as electroencephalography (EEG), computerized tomography (CT scan or CAT scan), magnetic resonance imaging (MRI scan), electromyography (EMG), positron emission tomography (PET scan or PET imagery), arteriogram (also called an angiogram) and single photon emission-computed tomography (SPECT). These diagnostic tests help physicians confirm or rule out the presence of a neurological disorder or other medical conditions. In order to diagnose brain-related diseases such as epilepsy, certain seizure disorders, degenerative disorders, sleep disorders, autism, brain tumors and migraines, and EEG is used to record brain cell activity through the skull for studying the functional states of the brain to help physicians for detecting and monitoring brain abnormalities.

In daily practice a neurologist in his or her clinic normally examines 20 min recordings of interictal periods. These will most commonly be the individual spike, the sharp wave and the spike wave complex. These are

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perceived in the majority of patients with epilepsy. This makes the detection of events in the interictal period i.e. The period between seizures or convulsions – play a vital role in the diagnosis of epilepsy. During the actual seizure the pattern observed in the EEG are made up of rhythmical waveforms for a wide variety of frequencies, polyspike activity, low-amplitude desynchronization, as well as spike-and wave complexes. Although interictal findings offer evidence of epilepsy, diagnosis on the other hand is based on observed epileptic seizures. The interictal indications of epilepsy can be identified using a short period of EEG recording. However a very infrequent nature of epileptic seizures makes long term video EEG monitoring necessary. Direct observation and use of patient activated alarm button remains the main form of epileptic detection. This was further improved by the ambulatory EEG system.

2. REAL TIME BIG DATA MINING METHODS

The term Real Time is used to describe how well a data mining algorithm can accommodate an ever increasing data load instantaneously. Upgrading conventional data mining to real time data mining is through the use of a method termed the Real Time Learning. The use of the RTL with conventional data mining methods enables Real Time Data Mining. Medical data mining has great potential for exploring the hidden patterns in the data sets of the medical domain. These patterns can be utilized for clinical diagnosis. However, the available raw medical data are widely distributed, heterogeneous in nature, and voluminous. These data need to be collected in an organized form. This collected data can be then integrated to form a hospital information system. Data mining technology provides a user-oriented approach to novel and hidden patterns in the data.

Storage and processing of these large data on the internet is not possible using traditional storage approaches. Big Data is fast becoming an important and growing tool in organizations around the world to improve efficiency and quality. Due to the importance Big Data technologies have become essential to today's competitive environment. All the manipulation of data is done by new generation technologies. Industries main concern is to maintain speed in processing large datasets in terms of waiting time between queries and running the program.

The revolution being brought about by Big Data mining is not restricted to the industrialized world. The main reason for this is the mobile devices spreading in developing countries. 80% of them are located in the developing world and responsible for the generation of vast volumes of data. The big data analyses of the developing nations are being undertaken by a UN initiative known as Global Pulse. They are using the Big Data Analysis to

1) Develop faster responses in times of a crisis by the detection and analysis of anomalies in the usage of digital media.
2) Fine tune various public policies with a closer representation of reality.
3) To check the success and failure of various policies in Real-Time and to make the necessary changes needed to ensure their success[9].

Real-time processing of big data mainly focuses on electricity, energy, smart city, intelligent transportation, and intelligent medical fields. During the information processing it needs to be able to make quick decisions, and feedback relevant instructions to the sensing terminal input within a very short time delay.

3. SCALP EEG AND EPILEPTIC SEIZURES

An EEG is a test that is employed to evaluate the electrical activity of the brain Brain cells communicate with each other through electrical impulses. An EEG can be used to help detect potential problems associated with this activity. An EEG tracks and records brain wave pattern using multiple electrodes attached to the brain. A collection of 128 to 2000 sample per second per channel are recorded in the form of multichannel time series. The main reason for such a sample collection is because of the electrical current being produced by individual neurons being too small to be recorded by the EEG (Nunez and Srinivasan, 2006). Instead EEG monitors multiple active neurons. Reference electrodes are used to set the baseline and the other channels are _____ in comparison to this baseline. A high amplitude EEG activity typically shows a seizure. However EEG does get affected by the electrical activity from other parts of the body like the heart, from the instrumental noise or

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from the surroundings. These are a few characteristics that needs to be considered in seizure detection (Qu and Gotman, 1997; Shoeb 2004). They are:

i. A large variety of seizure activity exists among individuals.
ii. Similarities do occur in the different occurrences of seizure happening in individuals.

On the basis of the above general characteristics, patient specific seizure detection algorithms have been developed previously (Qu and Gotman 1997; Shoeb and Gottag, 2010).

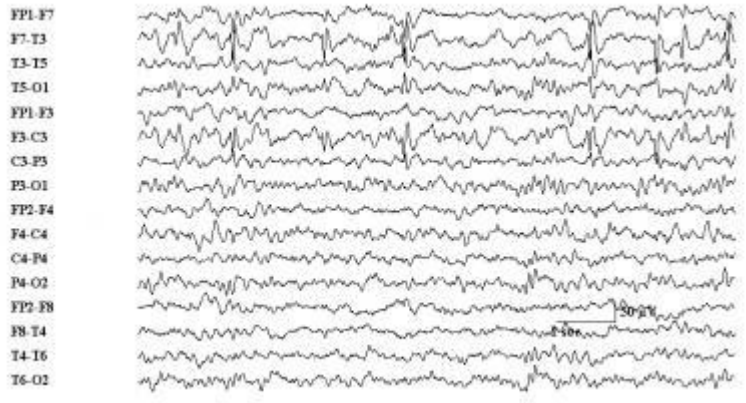

Fig: Sample EEG

The control centre of our bodies, the brain is a source of continuous tiny electrical signals. Most of us have brainwave patterns that look similar to other people. The EEG test makes use of sensors called electrodes is attached to our scalps with a paste and each of these are hooked up to a recording machine. The electrodes capture the electrical signals and record them on the computer.

The advantages and disadvantages of the EEG are that the electrodes do not affect our brains in any negative manners and can easily be attached and removed without complicated clinical procedures. The disadvantage being that the EEG records the brainwaves only during that time the test is being carried out. When not under the test, our brain wave patterns maybe very different.

During an epileptic seizure, our brain wave patterns shift from the norm. These changes can also be seen on the EEG if measure during the seizure. In certain cases, the brain activity pattern can be different from normal waveform even when an individual is not having a seizure. In such cases the EEG can be very useful. In certain people EEG shows brain wave patterns that differ from the baseline pattern that neurologists consider as normal. The detection of such unusual brain activity can be useful in predicting epilepsy but not with a 100% certainty.

4. EPILEPTIC SEIZURE PREDICTION

Localizing passing occurrences which can be the spikes during epileptic seizure. Visual detection of epileptic seizure from an EEG is very difficult as there is not a great difference during the seizure and non seizure periods. This is where the automated seizure detection techniques were tested with the aim of improving the speed and precision of the EEG wave pattern analysis. One method employed the use of the wavelet techniques to seek out the features of the EEG signals. This was based on the fact that the epileptic EEG. In contrast to the existing methods, the proposed method extracts unsupervised features from iEEG patterns to predict seizures.

Patient	EEG (hours)	Number of seizures	Detected duration (seconds)
chb01	20	7	63.1
chb02	15	3	82
chb03	20	7	57.4

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chb04	15	4	49
chb05	19	5	111
chb06	24	10	14.1
chb07	32	3	86

Fig2. Sample EEG data set is from EEG data base from CHB-MIT.

5. DIMENTIONALITY REDUCTION

Data size is to be reduced by 'top-k amplitude' measure It is suitable for processing unstructured data. The basic idea is to find abnormal, we must know what is normal. The entire data set is segmented into windows. Then we measure amplitude of each window for the non seizure activity. Then we take the cumulative mean of these Amplitudes (CMA). It is used to learn the normal pattern. After a large amount of such measures, we start to test new EEG data for seizures. We have to update CMA during this test phase, until we finds a deviation.

6. CONCLUSION

This paper had gone through different algorithms for epileptic seizure detection. The procedure of feature extraction and the formation of feature vector are designed such that spectral, fractal, spatial, and temporal information of seizure EEG are captured in the feature vectors. The wavelet algorithm has a sensitivity of 96% and an average detection delay of 1.89 s for the long term EEG Dataset A. It is observedtha the detection performance for the given method is better. The wavelet method is effective with both long term and short term EEG signal. The computational efficiency is also high when apply both WPT and Feature Detection. We have to develop methods for epileptic seizure detection in large EEG data. It should also be able to detect seizure in real time, with low latency and a good detection rate.

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