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EXPLORING THE INTERACTIONS AND CONNECTIVITY AMONG THE BRAIN REGIONS FOR IDENTIFICATION OF BRAIN DISORDERS

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ABSTRACT

Future of brain science is mainly focused on connectivity. Scientists have found that a cognitive function involves interactions between different brain regions in the state of rest. The image generating methods, such as EEG and fMRI, provide information on the intrinsic brain activity that is they demonstrate the connections of the brain areas within various regions that requires effective and efficient data mining techniques to determine the brain connectivity pattern associated with clinical rigidity to distinguish healthy brains from pathological brains from a number of brains. Clustering techniques are used to find the similar interaction patterns among brain regions and hence to identify the disorders in the brain. The aim of this study is to analyze and mine the various connectivity links for brain disorders and structure learning algorithms is studied for the interactions.

Keywords: brain connectivity, image processing, interaction patterns, machine learning.

1. INTRODUCTION

Human brain activity is very complex to be understood. Many psychiatric disorders like Schizophrenia and Somatoform Pain Disorder can so far neither be identified by biomarkers, nor by physiological or histological abnormalities of the brain. Functional magnetic resonance imaging (fMRI) opens up the opportunity to study human brain function in a non-invasive way. The basic signal of fMRI relies on the blood-oxygen-level-dependent (BOLD) effect, which allows indirectly imaging brain activity by changes in the blood flow related to the energy consumption of brain cells. Recently, resting-state fMRI has attracted considerable attention in the neuroscience community. Functional Magnetic Resonance Imaging (FMRI) is a technique for measuring brain activity that directly measures the blood flow in the brain there by providing information on brain activity.

As the electronic medical records are popular, the scale of the available medical data has grown tremendously so that machine learning method can be applied. To get information in the images, segment the images in different parts. The medical image segmentation is one of most difficult source of information of the human body which can help in reparative surgery, radiotherapy treatment planning, stereotactic neurosurgery. Several new techniques have been used to improve the biomedical research and one of these techniques is the MRI. The MRI is a non-invasive technique for medical imaging that uses the magnetic field and pulses of radio waves. It gives better visualization of soft tissues of human body. MRI has been early used to detect the brain tumors. This study focuses on hidden patterns and mining the interaction patterns by use of data mining with machine learning algorithms.

2. LITERATURE SUVEY

a) Imaging techniques

To obtain a better understanding of complex brain activity, it is essential to understand the complex interplay among brain regions during task and at rest. Cluster is defined as a set of subjects sharing a similar interaction pattern among their brain regions. CT (Computed Tomography) scan builds up a picture of the brain based on the differential absorption of X-rays but it reveal the gross features of the brain. EEG (Electro Encephalography) measure the electrical activity of the brain by according to the electrodes placed on the scalp but detecting changes in the brain is done on mille-sec level only. MEG (Magneto encephalography) measure the magnetic field produced by electrical activity in the brain e.g. speed of thought. It measures brain activity in 1/1000 of sec but it is more expensive. PET (Positron Emission Tomography) measures blood flow by injecting people with radioactive water and measure changes in radiation.

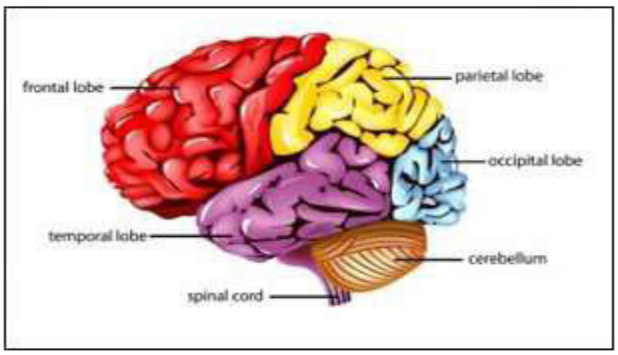
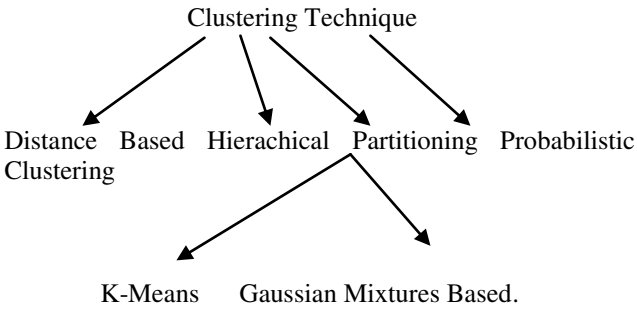


Figure-1. Brain regions.

Figure-2. MRI of Brain.

b) Classifications of clustering techniques



A cluster is a collection of objects which are similar" between them and are "dissimilar" to the objects belonging to other clusters. So clustering technique is used to detect, find similar interaction patterns among the brains regions. With the help of clustering techniques we capture the different interaction patterns in healthy and diseased subject. There are many ways to do data clustering. One of the popular algorithms is the K-means algorithm. The algorithm tries to put the entire dataset S into K clusters (i.e. $C_1;C_2;:::;C_k$) by randomly selecting K data points as a set of cluster centers.

c) Clustering techniques

Clustering is an important tool for creating abstractions and filtrations. A clustering method that propagates cluster labels from fiber to neighboring fiber. It assigns each unlabelled fiber to the cluster of its closest neighbor, if the closest neighbor is below a threshold. A partition of the data with a specific number of clusters can be acquired by setting a threshold on the maximal accepted distance. Various clustering techniques have been proposed to automatically obtain bundles that should represent anatomical structures. Found that the use of hierarchical clustering using single-link and a fiber similarity measure based on the mean distance between fibers gave the best results.

i. Clustering via K-Means and Spectral Clustering

The utilization of information driven bunching techniques for utilitarian connectivity examination in fMRI. K-Means and Spectral Clustering calculations as plan to the ordinarily utilized Seed-Based Analysis. K-Means (KM) Clustering Algorithm is based on minimizing the Euclidean distance in such a way that to maximizing correlation. Spectral Clustering (SC) utilizes the Eigen – deterioration of a couple shrewd partiality grid built from information focuses. SC can identify cluster with complex signal geometries. Seed based Correlation investigation recognizes voxel associated with interim course in a client specified seed locale, yet it requires priori learning. Independent component analysis isolates spatial sources account for activity variation across the brain & can be used to delineate different functional network.

ii. Clustering using expectation maximization algorithm

A novel based approach for joint clustering and point by point correspondence. Knowledge of point by point correspondence gives accurate and precise clustering and also gives tract-oriented quantitative analysis.

iii. Clustering using fuzzy c-means algorithm

Diffusion Tensor tracking provides line trajectory data representing neural fiber pathways throughout the brain. It is difficult to display and analyze the thousands of resulting tracks. An automated clustering approach was devised to segment the data into major component pathways. The fuzzy c-means (FCM) clustering algorithm was used, which provides probabilistic values for cluster membership based on distance measures between tracks. The FCM algorithm is a robust clustering algorithm that has been used in numerous engineering and medical applications. The FCM clustering algorithm can be applied to DT-MRI tracks and can produce reliable groupings of tracks

d) Interaction among brain regions

Functional connections between brain regions are supported by structural connectivity. Both functional and structural connectivity are estimated from in-vivo MRI and offer complementary information on brain organization and function. Functional Magnetic Resonance Imaging Functional MRI generates a series of 3-D volume images of the brain. Each image consists of about 60,000 voxels and the interval between time points is about 2-3 seconds. This approach is based on a set of time-series. The interactions between the clusters were determined and studied to get the exact region that is defected. The hierarchical clustering method which works well in the combination with interaction K means clustering. The clustering is done by splitting the brain image into various regions. These regions are ranked in a way with the defected region in the highest priority. Likewise the clustering is followed for the normal brain image too. Now this is compared with the defected brain image. On fMRI data the studies on Somatoform Pain Disorder and Schizophrenia and detects very interesting and meaningful interaction patterns. The Feature Selection Method is used to find out the region that is affected in the highest way. Also the time is shortened by dividing the brain regions. Crisp and fuzzy clustering are the most

important tools in the field of data mining and machine learning, and many algorithms thus have been proposed so far.

Somatoform pain disorder

Somatoform Pain Disorder has severe impact on the quality of living of the affected persons since the main symptom is severe and prolonged pain for which there is no medical explanation. The causes of this psychiatric disorder are not fully understood but the hypothesis is that patients have alternating mechanisms of observing and processing pain. Therefore subjects underwent alternating blocks of pain and non-painful stimulation while in the scanner. After pre-processing segment the data of each subject into 90 anatomical regions of interest (ROIs).

Schizophrenia

Schizophrenia is characterized by the impaired interaction between distributed brain regions particularly the striatum. Increased dopamine activity in the striatum is essential for schizophrenia and anti-dopaminergic treatment the main therapy of the disorder. Intrinsic brain networks are characterized by synchronous brain activity at rest

Existing system

A novel cluster notion for clustering multivariate time series based on attribute interactions was introduced. Interaction K-means (IKM), a partitioning clustering algorithm suitable to detect clusters of objects with similar interaction patterns is used

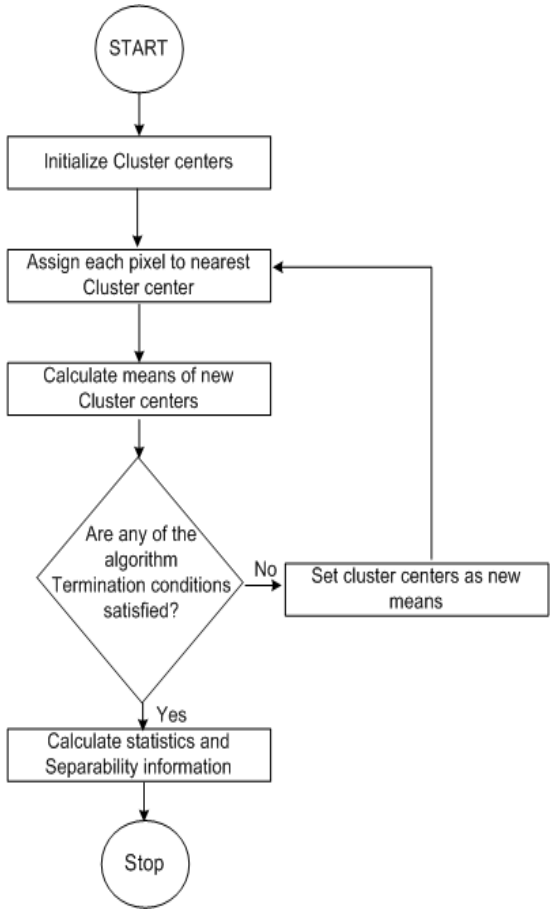
3. PROPOSED SYSTEM

Understanding mental disorders is a challenging task due to the complexity of brain structure and function, overlapping features between disorders, small numbers of data sets for training, heterogeneity within disorders, and a very large amount of high dimensional data. Diagnosis of mental disorders is based on a patient's self-reported experiences and observed behavior over the longitudinal course of the illness.

Algorithm

Interaction K means for feature selection is to be implemented. Interaction K-means (KM) for feature selection along with compression is used to detect clusters of objects that have similar interaction patterns. Similar to classical K-means IKM is an iterative algorithm, which efficiently converges towards a local minimum of the optimization space. The first step of IKM is the initialization. For IKM it is favorable that the initial clusters are balanced in size to avoid over fitting. Therefore, partition the data set into K equally sized random clusters. This similarity measure is always evaluated between an object and a cluster, and not between two objects. IKM converges as soon as no object changes its cluster assignment during two consecutive iterations. A major advantage of IKM is possibility to interpret the detected interaction pattern.

algorithm IKM (data set DS, integer K):
Clustering C Clustering bestClustering;
//initialization
for init := 1 . . . maxInit do
C := randomInit(DS,K);
for each C ∈ C do
MC := findModel(C);
while not converged or iter < maxIter do
//assignment
for each O ∈ DS do
O.cid = minC∈C EO,C
//update
for each C ∈ C do
MC := findModel(C);
if improvement of objective function.



4. CONCLUSION AND FUTURE WORK

In this paper, K-means (KM) clusters the data and discovers the relevant cluster specific interaction patterns. The algorithm IKM is a general technique for clustering multivariate time series. The idea behind is to understand the complex interaction patterns among brain regions using essential clustering, fast mining and find effective ways to identify Disorders. Future work is to calculate the interaction among the brain by taking into consideration time consumption.

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