AN EXPERT SYSTEM FOR DIAGNOSIS OF NEUROPSYCHIATRIC DISEASE

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ABSTRACT

Intelligent computing methods have been mostly used to the diagnosis of Neuro-Psychiatric Abnormalities dependent on EEG signals. A new approach made by research scholars to integrate Case based system along rule-based system (RBS) and Bayesian Model, this enhance the reasoning and computational efficiency of the problem-solving method. In this paper an integrated model of CBS for making cases, RBS is used for representing the inter relation of different symptoms with diseases by making different rules, and Bayesian methods is used for the probabilistic calculation. The Integration of these three methods is used for interpretation and diagnosis of Neuropsychiatric diseases based on electro encephalon graph and as well as FMRI symptoms. In this method first of all CBR is used for calculating similarity by using Jaccard coefficient, if similarity is not matched with calculated threshold value then a model is developed by using RBR and on the basis of this models Bayesian is applied for the process of diagnosis of the Neuropsychiatric diseases. The main objective of this work is to improve the computational effort with certain level of efficiency, accuracy and decision support.

Keywords - CBS, RBS, Prior probability ,Conditional probability, Joint probability, Dependent probability, Cognitive

I. INTRODUCTION

Intelligent Calculation is taken to include the development and application of artificial intelligence (Al) methods tools i.e. who have characteristics associated with intelligence in human behavior. Artificial Intelligence is the study of ideas that enable computers to do things that make people seem intelligent[9].The central objectives of the artificial intelligence are to make it more useful and to understand the principles that make intelligence possible. Many approaches have been proposed to apply Al methods,[14] techniques and paradigms to the solution of manufacturing problems. Intelligent computer systems and knowledge based systems (KBS) have been used in the medical diagnosis, planning, and treatment. Knowledge-based systems (KBS) composed of case-based reasoning (CBR), based on rules, reasoning (RBR) and based on a logic model (MBR) .then that smart computing method (ICM) are made up of artificial neural networks (ANN), genetic algorithm (GA), fuzzy logic (FL) and other. The combination of methods of KBS such that RBR-CBR, MBR-CBR and CBR-RBR-MBR and the combination of system in ICM is GA-ANN, FL-ANN, FL-GA and FL-ANN-GA. The combination of process of ICM to KBS is ANN-RBR, ANN-CBR, ANN-RBR-CBR, FL-RBR, FL-CBR and FL-CBR-ANN. We can make diseases description table by its different syndromes (Table 1) for the neuropsychiatric diseases on the basis of their three important parameters: Pysical, Psychophysical syndromes, EEG parameters and brain image (FMRI) analysis. Psychophysical syndromes is further divided into three parts: Psychological syndrome consisting of 12 sub syndromes such as: Anger , Abnormal Behavior , Anxiety, Agitation , Delusion , Distraction of Work , Fear , Hallucination , Need of Perfection , Stress , Hyper Activity ; and Cognitive syndrome consisting of 8 syndromes such as: Confusion in Decision Making , Hearing , Judgment , Learning , Forgetting Memory , Reasoning , Speech and Vision ; and Physical syndromes consisting of 8 syndromes such as: Climbing , Walking , Hearing , Locomotion , Vision , Speech , Over Sleeping and Hygiene . The EEG signal characteristics are ACC , CG , Frontal , Perietal , Oclipetal , and Temporal . The Image (FMRI) characteristics are ACC , CG , Frontal , Perietal, Oclipetal , Temporal and BG . In Table 1 first Coolum contains diseases. The second column contains syndromes of the diseases. The columns contain "1" if the respective symptoms is present in the disease shown in that row. For example,ADHD has Psychological syndrome such as: Anger ,Abnormal Behavior ,Anxiety ,Agitation , Distraction of Work , hyper activity . Therefore, the columns contain "1" as in Table 1.The third and fourth columns of the Table 1 contains EEG and FMRI parameters such as of a particular row contain "1" or "0" depending upon whether the particular symptom present or not in that particular disease.

Table 1 Syndromes Description Table

Disease	Psychophysical																											EEG						Image						
	Psychological											Cognitive								Physical																				
	Anger	Abnormal Behavior	Anxiety	Agitation	Delusion	Distraction of work	Fear	Hallucination	Need of Perfection	Stress	Hyper activity	Confusion in Decision Making	Hearing	Judgment	Learning	Forgetting Memory	Reasoning	Speech	Vision	Climbing	Walking	Hearing	Locomotion	Vision	Speech	Over Sleeping	Hygiene	ACC	CG	Frontal	Perietal	Oclipetal	Temporal	ACC	CG	Frontal	Perietal	Oclipetal	Temporal	BG
ADHD	1	1	1	1	0	1	0	0	0	0	1	0	1	1	1	0	0	0	1	1	0	1	0	1	0	0	1	0	0	1	0	0	0	0	0	1	1	0	1	0
Dementia	0	1	1	1	0	1	1	1	1	1	0	1	0	1	1	1	1	1	0	0	0	1	0	1	0	1	1	0	0	1	0	1	1	0	0	1	1	0	1	1
Mood Disorder	1	1	1	1	0	1	0	0	0	1	0	1	0	0	1	1	1	1	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	1	0	1	0	0	1	0
OCD	1	1	1	1	0	0	1	0	1	0	0	1	0	1	1	0	1	0	0	0	1	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0
SI	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	0	1	0	0	0	1	0	1	1	1	0	1	1	1	0	0

II. METHODOLOGY

2.1 Case Based System (CBS)

Case based reasoning system design which has been worked as follows (Fig-1). When a new problem is come, the CBR system retrieves the most similar cases. By using solutions retrieves, after that the reuse stage refers to a suggested solution, and then revision stage corroborate the solution, then retain stage can store the new case in the previous base of case[8][9][13][15][17].

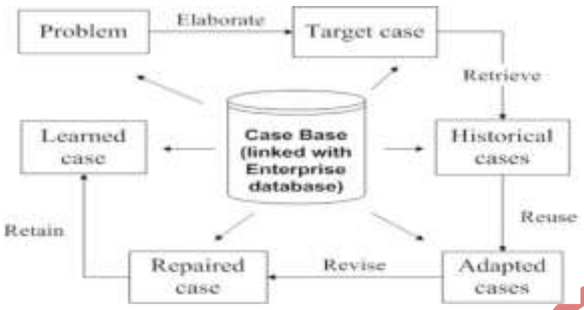

Fig-1 CBR System

Similarity Calculation

In this method we are calculating similarity by using Jacquard Coefficient. The Jacquard index, also known as the Jacquard similarity coefficient (originally coined coefficient de communauté by Paul Jacquard), is a statistic used for comparing the similarity and diversity of sample sets[18][21].

2.1.1 Similarity of Asymmetric Binary Attributes

Given two objects, a and b , each with n binary attributes, the Jacquard coefficient is a useful for finding of the overlap that a and b share with their attributes[1][3][7][8]. Each attribute of a and b can either be 0 or 1. The total number of each combination of attributes for both a and b are specified as follows:

a. represents the total number of attributes where a and b both have a value of 1.
b. represents the total number of attributes where the attribute of a is 0 and the attribute of b is 1.
c. represents the total number of attributes where the attribute of a is 1 and the attribute of b is 0.
d. represents the total number of attributes where A and B both have a value of 0.

Each attribute must fall into one of these four categories, meaning that

$$q+r+s+t=n$$

The Jaccard similarity coefficient, S(I,j), is given as:

$S(I,j)= q/(q+r+s)$

The Jaccard distance, dJ, is given as:

$d(I,j)=r+s/(q+r+s)$

2.2 Rule-Based System (RBR)

RBR is the process of drawing conclusions by linking together generalized rules, starting from scratch. Basically, RBR models are rooted in the philosophy belief that humans are rational beings and that the laws of logic are the laws of thoughts [5]. Although some rules are very specific, the goal is to formulate rules that are generally applicable [5]. One very important advantage of rules is the economy of storage they allow as compared to the storage of cases in CBR system. We believe that by adding the RBR technique to the documentation system, the system will be more efficient. It is clear from Table 2 that, when rules R_{111}, R_{112} and R_{113} are satisfied then R_{11} satisfied and when R_{11}, R_{12} and R_{13} are satisfied then R_1 is satisfied. Similarly as Table 2, rules for other diseases of are generated to any lower level to upper level. The hierarchal model will help to compute diseases probability. Rule-based model shows modular representation of the facts. Modules can be hierarchically related as shown in tree structure. Sign and symptoms at the lowest level are correlated to the parameters at the higher level and also the lower level parameters to the higher level parameters. In t his way, going from bottom to up i.e. lower to higher level and after travel of certain level we reach to the highest level i.e. root level.

R_{111}: if there is AN (z_1) & if AB (z_2) & if AX (z_3) & if AG(z4) & if DW(z5) & if HA (z6)THEN Psychological abnormality (z)
R_{112}: if there is HR(z_1) & if JG (z_2) & if problem in LR (z_3) & IF VS(z_4) THEN cognitive abnormality (z)
R_{113}: if there is CL (z_1) & if HR (z_2) & if VS (z_3) & if HG (z_4) THEN physical abnormality (z)
R_{11}: if there is problem in Psychological abnormality (z_1) & if cognitive abnormality (z_2) & if physical abnormality (z_3) THEN psychophysical abnormality (z)
R_{12}: if there is FL (z_1) THEN EEG pattern abnormality (z)
R_{13}: if there is images FL (z_1) & if images PL (z_2) & if images TL (z_3) THEN images pattern abnormality (z)
R_1: if psychophysical abnormality (z_1) & if EEG pattern abnormality (z_2) & if images pattern abnormality (z_3) THEN ADHD (Z)

Fig 1: Rules for Diagnosing ADHD

2.3 Bayesian Probabilistic Method

Bayesian statistics are about the alteration of belief. Bayesian statisticians look into statistically optimal ways of combining new information with old beliefs .Prior probability – personal belief or data. Input. Likelihood – likelihood of data given hypothesis. Posterior probability – probability of hypothesis given data. The term Bayesian refers to Thomas Bayes (1702–1761), who proved a special case of what is now called Bayes' theorem in a paper titled "An Essay towards solving a Problem in the Doctrine of Chances"[9]. In that special case, the prior and posterior distributions were Beta distributions and the data came from Bernoulli trials. It was Pierre-Simon Laplace(1749–1827) who introduced a general version of the theorem and used it to approach problems in celestial mechanics, medical statistics, reliability, and jurisprudence.[10] Early in Bayesian inference, "inverse probability" was an uniform priors following Laplace's principle of insufficient reason, was called (because it infers backwards from observations to parameters, or from effects to causes).[11] After 1920s, "inverse probability" was heavily replaced by a collection of methods that came to be called bayesian statistics.[11]

Bayes' theorem is stated mathematically as the following simple form:

$$P(A|B) = P(B|A)\,P(A)/P(B)$$

Where:

- P(A), the prior probability, is the initial degree of belief in A.
- P(A|B), the conditional probability, is the degree of belief having accounted for B.
- the quotient P(B|A)/P(B) represents the support B provides for A.

Another form of Bayes Theorem that is generally encountered when looking at two competing statements or hypotheses is:

$$P(A|B) = P(B|A)\,P(A)/P(B/A)P(A) + P(B|-A)\,P(-A)$$

Where:

1. P(A),the prior probability, is the initial degree of belief in A.
2. P(-A), is the corresponding probability of the initial degree of belief against A: 1-P(A)=P(-A)
3. P(B|A), the conditional probability, is the degree of belief in A, given evidence or background B.
4. P(B|-A), the conditional probability, is the degree of belief against A, given evidence or background B.
5. P(A|B), the posterior probability, is the probability for A after taking into account B for and against A.

- **Prior Probability:**

In Bayesian statistic inference, a prior probability distribution, is often called as simply the prior, of an unsure quantity p is the probability distribution that would express one's uncertainty about p before some evidence is taken into account.

There are two types of prior probabilities:

- **Conditional Probability:**

In probability theory, a conditional probability measures the probability of an event given that (by assumption, presumption, assertion or evidence) another event has occurred. If the events are A and B respectively, this is said to be "the probability of a given value of B", and is represented by P(A|B), or sometimes PB(A). In case that both "A" and "B" are categorical variables, conditional probability table is typically used to represent the conditional probability.

- **Posterior Probability:**

In Bayesian statistics, the posterior probability of a random event or an uncertain proposition is the conditional probability that is assigned after the relevant evidence or background is taken into account. The posterior probability is the probability distribution of a new or unknown quantity, used as a random variable, conditional on the evidence obtained from an experiment or survey. "Posterior", in this context, means after taking into account the relevant evidence related to the specific case being examined.

III. PROPOSED SYSTEM

There are three main steps for the diagnosis,

1. Use case based reasoning system for diagnosis

2. Use Rule based reasoning system for modeling

3. Use Bayesian Probabilistic model for Probability calculation

Steps involves in the algorithm are,

Step 1. Create a case based for new case

Step 2. Retrieve [search the existing similar case by Jacard Coeeficient]

(i) Problem Identification phase
(ii) Matching phase
(iii) Selecting

Step 3. Reuse

Step 4. Revise

Step 5. Retain

Step 6. Similarity value is compared by threshold value

Step 7. Value is in Normal patient given threshold value

Step 8. Display Patient is Normal

Step 9. Used RBR for generating rules

Step 10. Calculate Probability

(i) Calculate Prior Probability
(ii) Calculate conditional Probability
(iii) Calculate Joint Probability
(iv) Calculate Dependent Probability
(v) Calculate Probability for Disease

3.1 Algorithm

1. Randomly generate a NC

```
Create CBR for different diseases
Calculate Similarity S=q/q+r+s
If (S<= given ThN )
{
Display("Normal")
}
Else if(S>=ThN & S<=)
{
Adapt the most  similar case
Modified the receive case with Intelligent human Reason
Save the NC and update the index
}
Else
{
Create the RBR
Calculate PP
Calculate CP
Calculate JP
Calculate DP
Calculate PD
}
Provide the solution to the user
}
```

VI. CONCLUSION

By using this method, diagnosis of similar cases that occurred normally in neuropsychiatric abnormality is easily diagnose and will be given the appropriate solution if the similarity value is with in the given threshold value range Otherwise the diagnosis is done by using integrated method of RBR with Bayesian .Also this solution will reduce the time of process and will increase the processing speed and also save the memory space.

V. FUTURE SCOPE

The signs and symptoms of neuropsychiatry anomaly have been taken from the literature and from the consultation with the doctor and the researchers in the field. The sign, the symptoms can be changed or become unanimously, in consultation with several number of doctors and experiences in clinical environments. The experimentation in clinical environment could confirm the effectiveness of this method which is in question for the completion of the next phase of work.

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