Mental Disorder Detection : Bipolar Disorder Scrutinization Using Machine Learning

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MENTAL DISORDER DETECTION

BIPOLAR DISORDER SCRUTINIZATION USING MACHINE LEARNING

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Abstract— In today's modernized lifestyle there is an increase in stress and pressure, consequently people are facing mental issues and abnormalities. However, the utility of these abnormalities in distinguishing individual Bipolar disorder patients from Mood Disorder or healthy controls and stratify patients based on overall illness, burden has not been investigated in a large cohort. This research uses Machine Learning approach to screen Bipolar Disorder using the Mood Disorder Questionnaire (MDQ). . The data set was fed to Decision Tree Classifier which determines the most significant feature in the dataset and makes it the decision factor at that level of the decision tree. The testing samples are compared with the decision factor at each level and this decision takes each test case to a defined class (Screened Positive or Screened Negative). The Mood Disorder Questionnaire is a feasible method for detection of Bipolar Disorder.

Keywords— Bipolar Disorder, MDQ, Decision Tree Classifier, Machine Learning.

I. INTRODUCTION

Due to booming use of social media, peer pressure, increased stress level, competition, expectations, etc. have led to unstable teenage minds. Bipolar disorder (BD) is one of the most debilitating illnesses with an approximate lifetime prevalence of 4–5% in the general population .We have used mood disorder questionnaire (MDQ) to classify individuals, and predict whether an individual has BD. This questionnaire is based on symptoms of hypomania and mania. In hypomania mood swings last for a short period of time and in mania they last for a longer period. We have considered MDQ based on symptoms of mania because it does not consist of normal mood swings but gives an accurate prediction of bipolar disorder. Based on their answers we will analyze and using certain methodology we will predict whether the individual is suffering from bipolar disorder and inform him so that he may go for necessary treatment.

II. NEED AND APPLICABILITY

A. Need

After population explosion in India, the ratio of doctors to patients is 1:1800(ref) and amount of time for which a doctor can attend a patient is less than two minutes. For mental instabilities this amount of time is very less and hence a reliable system is required which is accurate in screening and takes relatively less amount of time and can be used by a large cohort. Also, many cases show that a mental instability in childhood often results in turning the person to a criminal. This can be avoided by periodically scrutinizing for various disorders.

B. Applicability

This experiment aims at helping the basic investigation to detect whether a person is suffering from Bipolar Disorder. This will save the time a doctor invests in preliminary tests. With these results the data can be used to train new doctors for identifying Bipolar Disease. It has a wide range of applications like assisting the doctors in a hospital, testing mental stability of students in schools/college, testing mental stability in organizations and also in common masses. It can also be used to aid the medical check-up that checks for various diseases. With such an experiment we can also scrutinize the presence of mental disorders in the subjects. Once tested positive we shall advise the subjects to visit a psychologist for further examinations thereby reducing the risk of disorders by detecting the disorders at early stages & by taking proper medical assistance.

III. LITERATURE SURVEY

This paper brings to light the difficulties that doctors have while diagnosing Bipolar Disorder. The research work states that the disease is misdiagnosed as MDD. (Major Depressive Disorder).At times Bipolar Disorder remains undetected and hence there are people who remain affected by the disease during their lifetime. A better chance of reducing the risk can

be attained if the screening tests are conducted for a large population on a regular basis. The MDQ is the preliminary approach to diagnose the presence of symptoms of Bipolar Disorder. This screening is followed by a thorough interview and examination, if there is the rarest possibility of a subject having the symptoms of the disease. The study has listed all the known symptoms of Bipolar Disorder in a table which can be very useful for further expansions. The study also mentions the use of MDQ as a reliable instrument for the screening of Bipolar Disorder. The research also jots down the points to be taken care of while dealing with such cases. The information included is regarding misdiagnosis and under diagnosis, interviewing aspects, treatment and also the challenges while dealing with such patients [1].

A group of Finnish doctors and psychiatrists conducted a screening test using the MDQ in Finnish language. The groups of subjects were categorized in three parts

1. New patients
2. Existing patients with new referral
3. The ones who initially didn't show signs of the disease but later their condition worsened.

A total of 113 patients were chosen out of which 109 patients were screened. Their mean age was around 37 years. 51 patients were females. All the patients in whom mental disorders were detected, were interviewed for further examinations. The result was quite satisfactory in case of Bipolar Disorder I. It detected 70% true positives in 10 patients. The paper also focuses on the inability to detect Bipolar Disorder II by using the MDQ. The study also reveals that the MDQ is not dependent on any language and can be translated to any language for proper screening if required. The study also validates the use of MDQ for screening of Bipolar Disorder [2].

The objective of this paper was to detect bipolar disorder in adult population using Brazilian version of the Mood Disorder Questionnaire as the patients of bipolar disorder are most of the time left untreated. There were a total of 114 subjects who took the test. The National Depressive and Manic-Depressive Association (DMDA), in the USA conducted a survey and concluded that over one third of the BD patients took 10 years to receive correct medication and most patients require at least more than one specialist (approx. 3.3 specialists).and only 53% are correctly diagnosed.

Hirschfeld et al. have made the 'mood disorder questionnaire' (MDQ) which is a self-screening test. This test is available in many languages like French, Italian, Spanish and Chinese.

This study was conducted on patients with primary mood disorders, with their consent. A total of 114 patients (34 males, 80 females) took part in this. The maximum expected accuracy was 90% and the least expected was 75%.

First, the MDQ was translated into Portuguese by two of the researchers of the paper. The MDQ is a questionnaire that has three question sets. The first set contains thirteen questions. The set two and set three have one question each. Each question has two choices viz. yes or no.

The results were that 69 patients (60.5%) received the diagnosis of bipolar disorder. Thus the Brazilian Portuguese version of the MDQ is a feasible method for improving the recognition of bipolar disorders [3].

The objective of the next paper was to detect bipolar disorder using 'mood disorder questionnaire' (MDQ) for persons with substance use. There were a total of 403 subjects who had taken the test. This was done because it was observed that people with alcohol consumption and drug consumption have a greater chance of going into depression and having BD than people with no alcohol and drug consumptions. The study took place during 2005 to 2007 with about 403 patients who fitted the criteria. The MDQ was translated into Dutch by two independent translators. MDQ is a questionnaire that has three question sets. The first set contains thirteen questions. If there was yes for more than seven questions in set one (section A) then it was considered as positive. For set two (section B) and three (section C) if most of conditions occurred and were serious then it was considered that the patient was having BD. To confirm it there were more two questions added, the first question was whether a symptom of section A occurred with substance abuse or not (section D) and second question was whether symptoms of section A occurred when they led a normal life. The MDQ result is considered positive if for original MDQ criteria in sections A, B and C are fulfilled. The MDQ result is positive if for modified MDQ sections A, B, C, D and E are fulfilled.

The result was: 28 of the 403 examined patients were excluded due to inadequate scoring in the MDQ, of the 375 remaining patients, 161 (43%) patients were MDQ positive and 214 (57%) were MDQ negative. A total of 50 MDQ positives (31%) were lost to follow-up due to relapse, drop-out or inability to be traced. Hence a total of 111 0f 161 MDQ positives and 59 of 214 MDQ negatives were used for calculations. Thus the MDQ is a feasible method for improving the recognition of bipolar disorders in patients with alcohol or substance use [4].

This article focuses manic depressive illness; bipolar disorder. It has been found that 2.2 millions of Americans has this mental disorder. Generally this begins in adolescents with 80% of patients experiencing this disorder and 15% ending their lives. Bipolar Disorder is different from major depressive disorder due to the presence of manic or hypomanic episodes. Manic episode i.e. a distinct period of abnormality cannot be cured by diagnosis hence we prefer anti-depressant treatment so we use MDQ to predict if a patient is affected by Bipolar Disorder. MDQ was developed by team of researchers, psychiatrists and consumer advocate to address critical need for accurate diagnosis of bipolar disorder, which can be deadly if left untreated [5].

In this research, lithium was used for optimal dosing and for early identification of patients with Bipolar Disorder. This survey was done by 117 health care professionals incorporating responses from 24 countries. All the patients were asked to check lithium serum levels on regular basis, with varying target range.

This survey was conducted during October 2016- April 2017 among professionals prescribing lithium for patients with Bipolar Disorder. Based on monitoring recommendations, a questionnaire was designed to assess how professionals prescribing lithium to patients with BD report to monitor these patients.

Questions were on local monitoring systems. This questionnaire consisted of 41 questions representing:

1. Target lithium serum levels and frequency of monitoring.
2. Monitoring frequency of physical and laboratory parameters.
3. Factors contributing to monitoring, reasons to monitor or not to monitor and use of guidelines or institutional protocols.
4. Personal characteristics of the patient (age, gender, country, experience with prescribing lithium, etc.).

In future it will be useful for patients to respond to deviating parameters which are to be monitored [6].

IV. Proposed Machine Learning Model

A. *Working of questionnaire*

The questionnaire has three question sets. The first set contains thirteen questions. The questions are based on unusual activities that normally don't happen with a healthy person. Each question has two choices viz. "YES" or "NO". If at all there is a response of "YES" by a user of MDQ to seven or more than seven questions in set 1, the user will be tested for further sets else the responses to the later sets are ignored and the person is termed "HEALTHY". If the person qualifies set 1 there is a question which comprises set 2 which asks for the overlap of the symptoms described in set 1 over a timeline. A response of "YES" to this set qualifies the person to set 3. Else the response of the user is discarded and the person is termed "HEALTHY".

The set 3 question asks for the degree of the problems faced by the user because of the symptoms. Originally the MDQ contains 4 options to this question viz. No Problem, Minor Problem, Moderate Problem and Severe Problem. And if the user chooses either of Moderate Problem and Severe Problem then the user is suspected of having Bipolar Disorder and the user is suggested to consult an expert. The user is termed as "HEALTHY" if he chooses "NO PROBLEM" or "MINOR PROBLEM". For the experiment the MDQ questionnaire is slightly modified for the sake of simplicity and symmetry. The set 3 contains four options which are reduced to two options viz. "MINOR PROBLEM" and "MAJOR PROBLEM". Thus, the entire questionnaire now has only two options for responses. "YES" or "NO" in set 1 and set 2 and "MINOR PROBLEM" and "MAJOR PROBLEM" in set 3.

This questionnaire is best suited to screen people with Bipolar 1 (depression and mania). It has a sensitivity of 0.73 and specificity of 0.90 for mood disorder patients. (Bipolar disorder falls under the category of Mood Disorders so this MDQ was chosen for the experiment.

B. *Dataset Generation*

The Dataset is collected (Refer TABLE 1) from 983 test screenings (864 negative screens and 119 positive screens) using the following interface implementation of the Mood Disorder Questionnaire. (Figure 1) The entries have been validated according to the scoring pattern provided by the Mood Disorder Questionnaire. Invalid entries have been discarded from the dataset lest they create ambiguity in predictions.

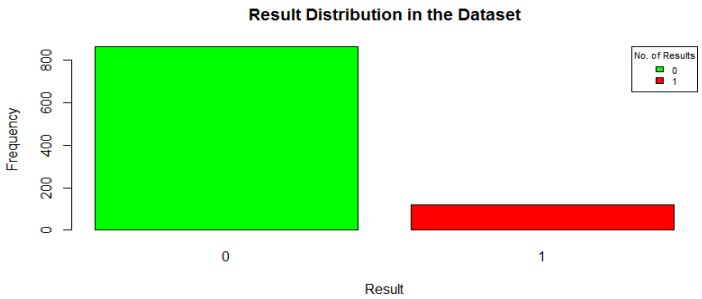

Fig. 1 The result distribution showing >850 "Negative Screens" represented by "0" and >100 "Positive Screens" represented by "1"

The experiment interface differs from the questionnaire in the last question where the original questionnaire provides 4 fields namely Low, Medium, High, Severe. We have clubbed Low + Medium as "Moderate" and High + Severe as "Severe". This doesn't affect the credibility of the data as the original questionnaire produces same effect for the clubbed types. This modification also helps in collecting clean data as it is internally stored as 0 or 1 for "No" or "Yes" in first fourteen questions and 0 or 1 for "Moderate" and "Severe" in the fifteenth question respectively.

Table 1 Input Questionnaire [7]

Question No.	***Questions***	***YES***	***NO***
Q1	Was there a period when you felt so good or so hyper that other people thought you were not your normal self or you were so hyper that you got into trouble?		
Q2	Was there a period when you were so irritable that you shouted at people or started fights or arguments		
Q3	Was there a period when you felt much more self-confident than usual?		
Q4	Was there a period when you got much less sleep than usual and found that you didn't really miss it?		
Q5	Was there a period when you were more talkative or spoke much faster than usual?		
Q6	Was there a period when thoughts raced through your head or you couldn't slow your mind down?		
Q7	Was there a period when you were so easily distracted by things around you that you had trouble concentrating or staying on track?		
Q8	Was there a period when you had more energy than usual?		
Q9	Was there a period when you were much more active or did many more things than usual?		

Q10	Was there a period when you were much more social or outgoing than usual, for example, you telephoned friends in the middle of the night?		
Q11	Was there a period when you were much more interested in sex than usual?		
Q12	Was there a period when you did things that were unusual for you or that other people might have thought were excessive, foolish, or risky?		
Q13	Was there a period when spending money got you or your family in trouble?		
Q14	If you checked YES to more than one of the above, have several of these ever happened during the same period of time?		
Q15	How much of a problem did any of these cause you - like being unable to work; having family, money or legal troubles; getting into arguments or fights?		

C. *Experiment Details*

The dataset of 983 was divided in the ratio of 60:40 where 60% of the data was used to train the model and 40% of the data was used to test the model. The model was implemented by using Decision Tree Classifier of Sklearn Package in Python. The Decision Tree Classifier class internally uses CART Algorithm to implement the Decision Tree.

D. *Experimental Analysis*

Confusion Matrix:

		Prediction	
		0	1
Test	0	[308	35]
	1	[12	39]

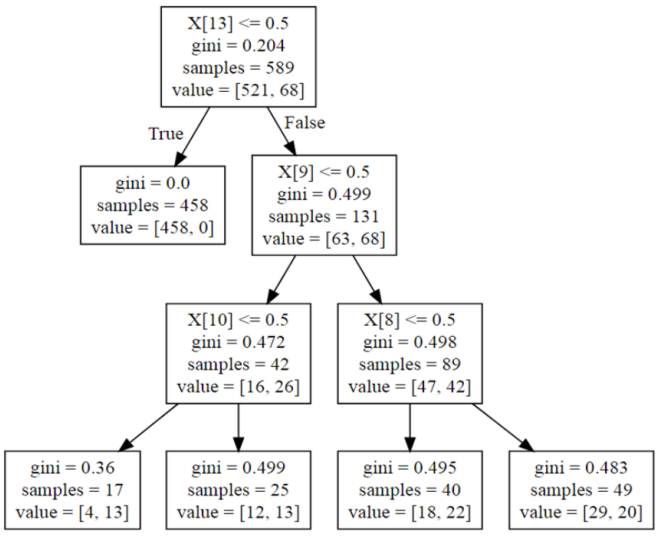

Fig. 2 Graph of Decision Tree Classifier

This states that out of 394 samples the model correctly predicts "Negative Screen" for 308 samples, false "Positive Screen" for 35 samples, true "Negative Screens" for 12 samples and 39 true "Positive Screens".

Thus Type-I error (level of significance) of wrongly predicting the presence of symptoms is seen to be more dominant than the Type-2 error in detection of a true case.

In a "Negative Screen" the model correctly predicts 308 samples out of 343 samples with a success rate of 89.79%.
In a "Positive Screen" the model correctly predicts 39 times out of 51 samples with a success rate of 76.47%.

The accuracy achieved in the experiment is 88.07%.There was a loss accuracy because in MDQ if someone answers less than 7 answers as NO, still the subject gets to answer the Q2 and Q3 and if the answer is to these is YES so this creates ambiguity as the answer to these questions should be NO.

The graph of our Decision Tree Classifier was as in Figure 2. In the level one of our graph X [13] means that the 13th question of our MDQ i.e. spending money brought you and your family in trouble; is the feature which distinguishes our dataset the most (Figure 3). In level two of our graph X [9] means the 9th question and X [10] means the 10th question. These two questions further divide our graph with 9th question having the second priority followed with 10th question having the third priority.

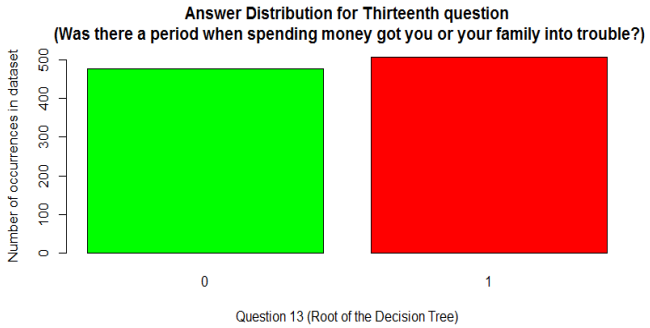

Fig. 3 The plot showing the response of the distinguisher attribute

V. CONCLUSION

From this study we conclude that Mood Disorder Questionnaire is a feasible method for detection of bipolar disorder using machine learning approach. We can generate decision tree based on data collected from particular region and determine major cause of disease for that particular region. Hence we can generate decision trees for different regions and it can be used for further analysis.

VI. REFERENCES

[1] Ursula McCormick, Bethany Murray, and Brittany McNew,"Diagnosis and treatment of patients with bipolar disorder: A review for advanced practice nurses," in Journal of the American Association of Nurse Practitioners: September 2015 - Volume 27 - Issue 9 - p 530–542 DOI : 10.1002/2327-6924.12275 , Available: https://journals.lww.com/jaanp/Abstract/2015/09000/Diagnosis_and_treatment_of_patients_with_bipolar.10.aspx

[2] Erkki Isometsä, Kirsi Suominen, Outi Mantere, Hanna Valtonen, Sami Leppämäki, Marita Pippingsköld and Petri Arvilommi,"The Mood Disorder Questionnaire improves recognition of bipolar disorder in

psychiatric care," in BMC Psychiatry 20033:8 Available: https://doi.org/10.1186/1471-244X-3-8

[3] Milena S. Castelo, Eduardo R. Carvalho, Emília S. Gerhard, Carlos Maurício C. Costa, Eduardo D. Ferreira, André F.Carvalho,"Validity of the Mood Disorder Questionnaire in a Brazilian psychiatric population," in Revista Brasileira de Psiquiatria 32(4), DOI: 10.1590/S1516-44462010000400016, Available: http://www.scielo.br/pdf/rbp/2010nahead/aop2410.pdf

[4] Farren, Conor K et al. "Bipolar disorder and alcohol use disorder: a review" Current psychiatry reports vol. 14,6 (2012): 659-66, Print ISSN:1523-3812, Online ISSN:1535-1645 Available: https://doi.org/10.1007/s11920-012-0320-9.

[5] Article : what is bipolar disorder? Available: http://med.stanford.edu/bipolar/bipolar.html

[6] Nederlof, M., Heerdink, E. R., Egberts, A., Wilting, I., Stoker, L. J., Hoekstra, R., & Kupka, R. W. (2018), "Monitoring of patients treated with lithium for bipolar disorder: an international survey," in International journal of bipolar disorders, 6(1), 12. doi:10.1186/s40345-018-0120-1 Available: https://doi.org/10.1186/s40345-018-0120-1

[7] Hirschfeld, Robert M. A.. "The Mood Disorder Questionnaire: A Simple, Patient-Rated Screening Instrument for Bipolar Disorder," in Primary care companion to the Journal of clinical psychiatry vol. 4,1 (2002):9-11.