Pattern Variation Method with Modified Weights to Detect Lie using Artificial Neural Network (PVMMWANN)

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Abstract— World is full of people having infinite behavioural patterns. Versatile behavior of people leads to different types of activities by the people. Some people are aggressive, some are cool, and some are truthful while some people, always or sometimes lie. This leads to a serious of problems while investigations. A guilty person tries to conceal his deed by telling lie, while investigations. A lie detection expert system can be designed. This approach is based on a already devised method PVMANN which detects lie by asking some simple questions. In the paper, PVMMWANN an algorithm is designed to detect weights of the ANN which can be used to get rid of the drawbacks seen in PVMANN.

Keywords - Lie detection, Artificial Neural Network (ANN), Pattern Recognition, Segmentation, and Modified Weights

I.Introduction

The classical methods and the present methods used to detect lie are not totally perfect in detecting lie. In some lie detection tests like narco, the person under investigation are investigated under the influence of some drugs which may be fatal for the individual and looks inhuman. Other methods are based on analysis of individuals heart beat, pressure etc. which may vary even if an innocent person is investigated. The method used in this paper is just asking the person under investigation, some simple questions in a cool atmosphere without creating tension. Artificial Neural Network (ANN) is used

here to analyze the question patterns and lead to some conclusion [1, 7]. An expert system is designed using ANNs which reads the variations in answering patterns in order to find the truthfulness of the individual. A similar approach, Pattern Variation Method to Detect Lie Using Artificial Neural Network (PVMANN) had already been done before [8]. But some drawbacks are present in this method due to the selection of weights. A modified approach is Pattern Variation Method with Modified Weights to Detect Lie Using Artificial Neural Network (PVMMWANN). In this method an algorithm is designed in order to select weights which when used overcomes the drawbacks of the previous method.

Mic Hanlon, Scientists at Manchester Metropolitan University interprets that lie detection can be performed most accurately by facial gestures, using just a laptop and a camera [2]. Patrick Kennedy used Artificial Intelligence (AI) technology, to detect lies via small changes in facial expressions [3]. Mark Williams Pontin reviewed on lie detection based on facial expressions [4].

Leonard Saxe who was a Psychologist had made an argument, that a person's veracity can be detected by monitoring psycho physiological changes are more myth than reality. Even the term "lie detector," used to refer to polygraph testing, which is a misnomer and called "lie detection" [5]. John P. Clark and Larry L. Tifft American Sociologist worked on Polygraphic validation on lie detection [6].

This paper is divided into two sections. Section 1 discusses methodology and Section 2 discusses the weight finding algorithm, section 3 discusses the lie detection algorithm and result analysis is discussed in Section 4 followed by discussion and conclusion.

II. Methodology

An Artificial Neural Network (ANN) has been used here as shown in Figure 1. It consists of five input neurons, where x_i is the input vector for i= 1 to 5. The input vector is a binary vector which is the output of a binary answer set. The weights are represented by a weight vector w_i for i = 1 to 5. The weights in this method are not fixed to one. An alternate approach is applied here using a weight finding algorithm. Weights

are set in such a way so that if answers are inverted in a symmetric way for different days, will not result in a false conclusion.
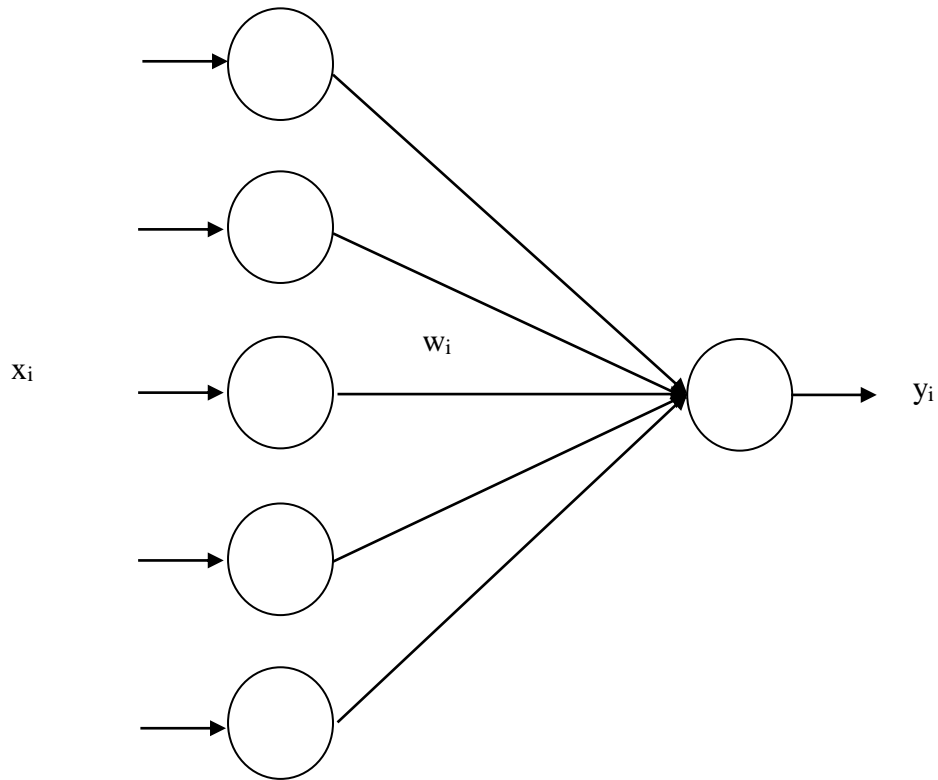

Figure 1. ANN used for lie detection using modified weights

An individual is questioned for three days. Five questions with Boolean answers are asked to the individual on first day, which is considered as the initial day. The answers are stored as a binary vector. The vector is presented to the ANN as input vector. Next two days are considered as Day-1 and Day-2. Same questions are asked to the same individual on Day-1 and Day-2. Similarly, input vectors for Day-1 and Day-2 are presented to the ANN.

The net input of the ANN is calculated as given in the following equations:

$ynet_i = \sum_{i=1}^{n} x_i w_i$ Equation…1

For initial day,

i = ini

For Day-1

i = 1

For Day-2

i = 2

For i =1 to 2

d_i is the deviation in answer pattern between initial day and following days as given in the following equation:

$d_i = ynet_{ini} - ynet_i$ Equation…2

d is the mean deviation in answer pattern as given in the following equation:

$d = \sum_{i=1}^{n}$ (di)/n   Equation…3

III.   Algorithm weight finding

STEP 1: Initialize, w_1 = 1 [Where w_1 is the initial weight]

STEP 1: Initialize, i = 2

STEP 3: Repeat Step 4 to Step 7 while i<=n

       [Where n is the number of input neurons in the ANN]

       STEP 4: Let   s = 0, j = 1

       STEP 5: Repeat Step 6 while j <= i-1

            STEP 6: Calculate

               $s = s + w_j$

            STEP 7: Calculate

               $w_i = s + 1$

               i = i + 1

STEP 8: Stop

Example 1. To find out the weights for an ANN with five input neurons the above weight finding algorithm can be applied. In this example weight and other variables are initialized as indicated in the above algorithm. The initial weight is considered as 1 and is selected as random weight. Five epochs produces different weights. The weight produced in the successive epochs is 2, 4, 8 and 16. These weights if applied to the method do not generate any type of ambiguous results. The final weight vector is {1, 2, 4, 8, 16}.

IV.   Significance of weight modifications

In this previous related work on lie detection, it was found that if the weights are fixed to 1, some problems were created. For example, one person gives negative answers for first two questions and positive answers for rest three questions, on initial day. Next day he gives positive answers for first three questions and negative answers for last two questions. On third day he repeats the initial day pattern. Applying the previous weights detects truth finally. But the person under investigation gave the wrong pattern of answers. If the new set of weights is applied, the system detects lie on a single variation in patterns because different input neurons are allotted different decision making power with the help of variable weights. The weights are chosen in such a way, that combinations of two or more than two weights do not produce any other weight in the set as shown in Equation 4.

If W is a set of weights with n elements.

For all i, where $1 \leq i \leq n$

$\{\sum_{i=1}^{j} (w_i) <> w_k$, where $2 =< j <= n$ and $2 =< k <= n, i <> k\}$

   Equation…4

V. Algorithm "PVMMWANN"

STEP 1: Read the vector 'xini' [Where 'xini' is the initial answer vector]

STEP 2: Apply the Algorithm 'Weight Finding' to find out the modified weights.

STEP 3: Calculate the net output of initial answer vector

   $ynet_{ini} = \sum_{i=1}^{n} w[i] * xini[i]$

   [Where n is the number of questions]

STEP 4: Read the vector 'x_1' [Where 'x_1' is the next day answer vector]

STEP 5: Calculate the net output of day-1 answer vector

   $ynet_1 = \sum_{i=1}^{n} w[i] * x_1[i]$

STEP 6: Calculate the absolute difference from first set of answers to answers of day1

   $di[1] = abs(ynet_{ini} - ynet_1)$

STEP 7: Read the vector 'x_2' [Where 'x_2' is the next day answer vector]

STEP 8: Calculate the net output of day-2 answer vector

$$\text{ynet}_2 = \sum_{i=1}^{n} \quad \text{w[i]} * \text{x}_2\text{[i]}$$

STEP 9: Calculate the absolute difference from first set of answers to answers of day1

di[2] =abs(ynet$_{\text{ini}}$ – ynet$_2$)

STEP 10: Calculate Average Difference

d= (di[1] + di[2])/2

STEP 11: If d==0 then display Truth else display Liar.

STEP 12: STOP

Explanation of the algorithm: In the above algorithm, an initial answer vector is taken. This vector is actually created from the answers which are Boolean in nature from the person under investigation. The weight finding algorithm as discussed Section 3 is applied to find the modified weights. The net output is calculated using the modified weights and initial answer vector. Another answer vector is created using the answers obtained from the person under investigation next day. Same set of questions are asked. And same process is applied to obtain the net output of day 1. In the next step the absolute difference of the initial net output and the net output obtained on day 1 is calculated.. Similarly, net output and absolute difference of day 2 is obtained. To obtain more accuracy an average of the two values obtained on day 1 and day 2 is obtained. If there is no variation and little variation in the answer patterns of the person under investigation is observed then the person is considered as true. In case of huge variation the person is considered as liar. If the value of d is 0 or very small then there is no or small variation in answer pattern.

VI.   Result analysis and comparison between "PVMANN" and "PVMMWANN"

The experiment was carried out for three consecutive days. A set of five questions were asked to different individuals. Table 1, Table 2 and Table 3 shows the questions asked to some individuals in three days using the previous method 'PVMANN'. Table 4, Table 5 and Table 6 shows the answer sets produced by same individuals in three days using the method 'PVMMWANN'.

The questions given in Table 1 to 6 are created at random and are general questions. These questions are asked to the person under investigation to find the variations in his answers on different days.

The decision "True or Liar" is taken on the basis of degree of variation in answer pattern obtained from the same question set. A person who is speaking the truth gives same type of answers if asked several times. The Liar deviates from his answers as he is not able to remember what type of answer he has given previously for a question.

Table 1: Answer vector of Individual-1 using PVMANN

Individual 1/ PVMANN	Initial Day	Day-1	Day-2	d	Result
Question 1	1	0	1		
Question 2	1	0	0		
Question 3	0	1	1	0	True
Question 4	0	1	0		
Question 5	1	1	1		

Table 2: Answer vector of Individual-2 using PVMANN

Individual 2/ PVMANN	Initial Day	Day-1	Day-2	d	Result
Question 1	1	1	1		
Question 2	1	1	1		
Question 3	0	0	0	0	True
Question 4	0	0	0		
Question 5	1	1	1		

Table 3: Answer vector of Individual-3 using PVMANN

Individual 1/ PVMANN	Initial Day	Day-1	Day-2	d	Result
Question 1	1	1	1		
Question 2	1	1	1		

Question 3	1	1	0	1	Liar
Question 4	0	0	0		
Question 5	1	0	0		

Table 4: Answer vector of Individual-1 using PVMMWANN

Individual 1/ PVMANN	Initial Day	Day-1	Day-2	d	Result
Question 1	1	0	1		
Question 2	1	0	0		
Question 3	0	1	1	5.500	Liar
Question 4	0	1	0		
Question 5	1	1	1		

Table 5: Answer vector of Individual-2 using PVMMWANN

Individual 2/ PVMANN	Initial Day	Day-1	Day-2	d	Result
Question 1	1	1	1		
Question 2	1	1	1		
Question 3	0	0	0	0	True
Question 4	0	0	0		
Question 5	1	1	1		

Table 6: Answer vector of Individual-3 using PVMMWANN

Individual 1/ PVMANN	Initial Day	Day-1	Day-2	d	Result
Question 1	1	1	1		
Question 2	1	1	1		
Question 3	1	1	0	18	Liar
Question 4	0	0	0		
Question 5	1	0	0		

Table 7: Comparison of PVMMWANN with other methods

S.No.	Name of the Lie detection method	Possibility of impact on health of the person under investigation	Environment	Nature of the method	Requirements	Possibility of outcome
1.	Facial Gesture Method [2]	Person may become nervous under the influence of camera	Nervous	Moderate	Camera and Laptop	Good
2.	Facial Expressions by AI [3]	Nervousness may be a problem	Nervous	Moderate	Camera and Computer	Good
3.	Physiological changes [5]	Nervousness and Psychological impact creates problem	Nervous	Moderate	-	Good
4.	Poly-graphic Validation [6]	Impact on breathing rate, pulse, blood pressure, increase tension, nervousness	Nervous	Moderate	Sensors attached to the person undergoing test, Polygraph is a machine	Good
5.	Narco	May cause	Unfavourable	Complex	Drugs like	Not always

		Health hazards due to the influence of medicines	to the person under investigation		Sodium Pentothal, Sodium, Amytal Scopolamine	fruitful, no legal validity
6.	PVMANN	No	Normal	Simple	Computer	Good
7.	PVMMWANN	No	Normal	Simple	Computer	Overcomes the limitations of PVMANN

Explanation of Table 7: Very less work has been done in this field. The present methods of lie detection under practice mostly use some devices like camera, sensors and other equipments under the influence of which a normal human being becomes nervous. Nervousness produces some abnormal patterns in his body which when sensed by the devices produces abnormal test results. This may sometimes prove an innocent person guilty. Even some test put the human being under drug to find out the fact unwillingly. This method seems inhuman. This paper is an approach to use simple tools like questionnaires under normal environment to find the fact. ANN helps in finding out the fact efficiently.

VII Discussion

The traditional methods are biased towards testing human psychology. Even, now a day Narco tests are performed to find out the truth which seems inhuman and sometimes may be fatal for the person under investigation. The current approach is an intelligent trap or may be called web of questions which uses the ANN technique in order to converge towards the truth without causing any harm to the humanity. Table 7 shows how the current approach is compared with the traditional methods in many aspects.

VIII Conclusion

PVMMWANN is an approach which uses unsupervised ANN with predetermined weights. The predetermined weights are calculated using an algorithm, devised here. The ANN uses a Self Organizing Map (SOM), to find out the reality which is Boolean in nature i.e. either true or false. This approach overcomes the limitation of the previously used method called PVMANN where if a situation arises where number of wrong answers and correct answers are same, then it generates zero difference, which concludes a liar value as true value. Furthermore, this approach is better than the classical methods of lie detection. Most of the traditional methods use facial expressions, nervousness and other parameters related to human psychology which may not be always correct. The approach used in this paper clears the way to devise questions in such a way which instead of confusing the person under investigation extracts out the truth with ease. Future scope of this approach may be fruitful with further research.

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