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Perceptron Partition Model to Minimize Input Matrix

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Abstract. Implementation of Neuron Network model using Perceptron has not given optimal result in real time learning. The large number of inputs expressed in matrix form makes the process slower in pattern recognition. So, it takes characteristic to represent all the input matrices by using the partition method. By partitioning each input and with the best weight and using the activation function will produce an output value. And learning is valid in recognizing patterns only 1 iteration only. Further validation is done on the water mill control module with dissolved oxygen input, water pH, salinity and water temperature. With Perceptron Partition learning algorithm more real-time than perceptron model. Testing on the waterwheel input whether rotating or stopping by Matrix Laboratory software simulation.

1. Introduction

Neuron network model using Perceptron on system learning is not effective, the learning process is not real time. Some neural network models do more iterations on learning using weight changes in a loop to get maximum weight, such as Kohonen Network, Hetero Associative Memory, Learning Vector Quantization, Delta rule, McCulloch-Pitts, Heb Rule, Back Propagation. Also, the generalization capability of perceptron is limited with binary. (J.J.De Groote & D.M.L.Barbato.2008). And the weakness of the neural network to operate the network needs training so that when the amount of data is large, and the time spent for the training process is very long (T.Sutojo et.al.2011). And a Neural Network model looks good is determined by the relationship between neurons in the network architecture (T.Sutojoet al.2011). So we need a model that can determine how to find the best weight value to optimize system learning in recognizing a pattern during the process. Problems on Perceptron method on input data too large in the form of matrix will affect the length of learning, so it requires a model that can recognize a special input only or a representative partition only, the system can already recognize the pattern. To overcome this the input data is stored in matrix form, then the partition becomes small data and becomes characteristic for the pattern recognition system (T.Sutojo,

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dkk.2012). And when designing artificial neural networks, the need for nodes and layers should be estimated. For large networks then it is impossible to use learning methods that only accommodate small networks (Diyah Puspitaningrum.2006). Especially if the online-based system, which takes very real time, perceptron method difficult to apply. (Andrii Shalaginov.2016). Furthermore, Perceptron model of this partition will be tested on a control input on Waterwheel with variable: Dissolved Oxygen, Temperature, salinity and PH water.

2. Algorithm Method that Proposed

2.1. Perceptron

Perceptron model is a training method that has 3 layers and its neurons are sensor unit, association unit and unit of response unit. The three regular units are in a retina. Normally the sensor unit and -1 and the association unit use the binary activation function, while the response unit uses bipolar activation of -1.0 and -1. The activation function for each association unit is a binary function and usually the signal sent from the associate unit to the output unit is a binary signal (0 or 1). The output of perceptron is y, where y = f (y_in) with the active function is as follows:

$$f(x = \begin{Bmatrix} 1\ if\ y_{in} > \theta \\ 0\ if\ -\theta \le y_{in} \le \theta \\ -1\ if\ y_{in} < -\theta \end{Bmatrix} \quad (1)$$

The weight of the response or output unit is adjusted by the training method on perceptron. For each input, the network will calculate the response of the output unit. Then the network will determine whether an error occurs for an existing pattern by comparing the output calculation with the target value. The network will not distinguish between an error in the calculation of output = 0 and target = -1, unless the output = + 1 and its target = -1. To calculate, the weight change is used: w1 (new) = w1 (old) + αtxi. Where the value of the target is t ie +1 or -1 and α is the learning rate. Next the output of the associate unit in a simple perceptron is a binary vector. The vector is required as an input signal to the output unit in each section that follows it.

Perceptron algorithm, namely:

1. Initialize all weights and biases. Set Learning rate. Set threshold value (Threshold value).
2. Set the input activation, Calculate the response for the output unit. Put it into the activation function.
3. Compare the output value of Y network with the target.
4. If Y is not the same as the target, change the weight and bias.
5. Perform continuous iterations have the same network output pattern as the target. This means that when all network output has recognized the pattern well and the iteration is stopped.
6. Initialize all weights and biases. Set Learning rate. Set threshold value (Threshold value).
7. Set the input activation, Calculate the response for the output unit. Insert it into the activation function.
8. Compare the output value of Y network with the target.
9. If Y is not the same as the target, change the weight and bias.
1. 10.Perform continuous iterations having the same network output pattern as the target. This means that when all network output has recognized the pattern well and the iteration is stopped.

2.2. Partition matrix

The Partition Matrix is dividing the matrix into smaller matrices by including horizontal and vertical lines between rows and matrix columns. A matrix of small size of matrix partition is called sub matrix.

The Matrix partition is used to simplify the matrix of a large size into a small matrix making it easier to operate for a particular purpose. Each sub-matrix of the partition result can always be returned to its original matrix. And the Partition matrix will be more easily solved by dividing a matrix from a number of smaller submatrices. By introducing vertical and horizontal lines into the matrix, on the partition into blocks. It is a natural way to partition many matrices, especially those that appear in certain applications (David Poole.2006).

To simplify calculations sometimes a large matrix needs to be partitioned earlier by dividing a large matrix into smaller sub-matrices. For example, the input matrix in 1000x1000, of course to process the two images takes a very long time and it is often impossible to multiply both matrices due to the limited computer memory to store the matrix. To solve this problem the two matrices are divided into smaller sizes, for example into a 100x100 matrix. (T.Sutojo.2010). The partition matrix is in principle no different from the matrix already known. The difference lies only in the matrix element, where in the partitioned matrix, the element is a matrix block of smaller size.

P=

$$\left\{\begin{array}{cccccc} a11 & \dots & a1(n-k) & a1(n-(k-1)) & \dots & a1n \\ \cdot\cdot & \cdot\cdot & \cdot\cdot & \cdot\cdot\ \cdot\cdot & & \cdot\cdot \\ a(m-k)1 & \cdot\cdot & a(m-k)(n-k) & a(m-k)(n-(k-1)) & \cdot\cdot & a(m-k)n \\ a(m(k-1)) & \therefore & a(m(k-1)(n-k) & a(m(k-1)(n-(k-1)) & \cdot\cdot & a(m(k-1))n \\ \cdot\cdot & & \dots & \dots & & \dots \\ am1 & am(n-1) & am(n-(k-1)) & \cdot\cdot & & am \end{array}\right\}$$

Fig.2.1 Genaral Matrix

P=

$$\left\{\begin{array}{ccc|ccc} a11 & \dots & a1(n-k) & a1(n-(k-1)) & \dots & a1n \\ \cdot\cdot & \cdot\cdot & \cdot\cdot & \cdot\cdot\ \cdot\cdot & & \cdot\cdot \\ a(m-k)1 & \cdot\cdot & a(m-k)(n-k) & a(m-k)(n-(k-1)) & \cdot\cdot & a(m-k)n \\ \hline a(m(k-1)) & \therefore & a(m(k-1)(n-k) & a(m(k-1)(n-(k-1)) & \cdot\cdot & a(m(k-1))n \\ \cdot\cdot & & \dots & \dots & & \dots \\ am1 & am(n-1) & am(n-(k-1)) & \cdot\cdot & & am \end{array}\right\}$$

Fig.2.2Partition Matrix

Square matrix partitioned over 2 rows and 2 matrix columns or 2x2 bloc matrices. This partition matrix is a matrix that is made into a smaller size matrix by inserting horizontal and vertical lines between rows and columns of the matrix. A matrix of small size of matrix partition is called sub matrix (Ilhamsyah et.all.2017).

2.3. Genetic Algorithm

The theory that first explains how the genetic algorithm works is the Schemata theory. This theory was sparked by John Holland in 1975. At that time, Holland published the book Adaptation in Natural and Artificial System in which there was a mathematical analysis of the workings of the genetic algorithm (Yandra Arkenan.2012). Genetic algorithm aims to find individuals who have the most optimal fitness value (can be maximum or minimum, depending on the needs).

In this algorithm, the evolution of the process simulated in terms of natural selection and individual reproduction to automate problem-solving processes. Selection, recombination (cross-over) and mutations lead to the evolution of solutions through the survival of the fittest hypothesis. A study proposes a new perceptron with non-additive properties, which are named a single layer of gray. Perceptron, by measuring the relationship values between input patterns and this class for individual attributes with gray relational analysis. In addition, connection weights are interpreted as the importance of each input signal and can be determined by a genetic algorithm-based learning algorithm.

3. Results and Discussion

3.1. Research variable

The variable in this research contain of the independent variable and 1 dependent variable. Using the algorithm perceptron with 2 layers (input and output).

3.2. Field data

Field data at Tanjung Ibus village, Stabat sub-district of Langkat Regency in shrimp pond.

Table 1. (Results: interview of Mr. Uncu shrimp farm in Stabat)

X1 (Temperature/°C)	Y1 (DO(mg/l))	Z1 (PH)	W1 (Salinity)
11	4 ppm	7,2 s/d 7,8	17
12	4,2 ppm	8,0 s/d 8,5	18-20

Table 2. The relationship between PH and temperature (Matrix [16 x 4]).

3.3. Process Diagram Block

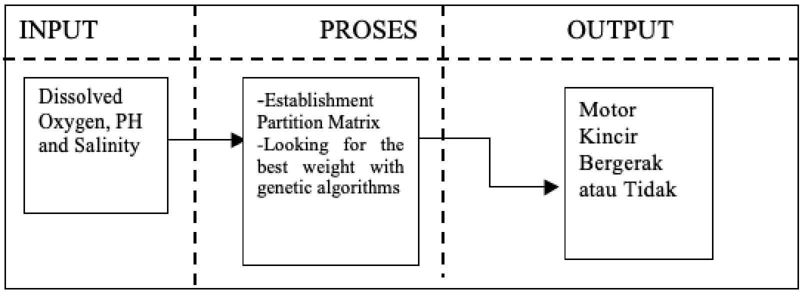

Fig. 1 Block Diagram of Perceptron Partition Model

0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0
0	0	1	0

Matrix form 2x2:

$$\begin{bmatrix} a1,1 & a1,2 \\ a2,1 & a2,2 \end{bmatrix} \begin{bmatrix} a1,3 & a1,4 \\ a2,3 & a2,4 \end{bmatrix}$$

$$\begin{bmatrix} a3,1 & a3,2 \\ a4,1 & a4,2 \end{bmatrix} \begin{bmatrix} a3,3 & a3,4 \\ a4,3 & a4,4 \end{bmatrix}$$

$\begin{bmatrix} a5,1 & a5,2 \\ a6,1 & a6,2 \end{bmatrix} \begin{bmatrix} a5,3 & a5,4 \\ a6,3 & a6,4 \end{bmatrix}$
$\begin{bmatrix} a7,1 & a7,2 \\ a8,1 & a8,2 \end{bmatrix} \begin{bmatrix} a7,3 & a7,4 \\ a8,3 & a8,4 \end{bmatrix}$
$\begin{bmatrix} a9,1 & a9,2 \\ a10,,1 & a10,2 \end{bmatrix} \begin{bmatrix} a9,3 & a9,4 \\ a10,3 & a10,4 \end{bmatrix}$
$\begin{bmatrix} a11,1 & a11,2 \\ a12,1 & a12,.2 \end{bmatrix} \begin{bmatrix} a11,3 & a3,4 \\ a12,3 & a4,4 \end{bmatrix}$
$\begin{bmatrix} a13,1 & a13,2 \\ a14,1 & a14,2 \end{bmatrix} \begin{bmatrix} a13,3 & a5,4 \\ a14,3 & a6,4 \end{bmatrix}$
$\begin{bmatrix} a15,1 & a15,2 \\ a16,1 & a16,2 \end{bmatrix} \begin{bmatrix} a15,3 & a7,4 \\ a16,3 & a8,4 \end{bmatrix}$

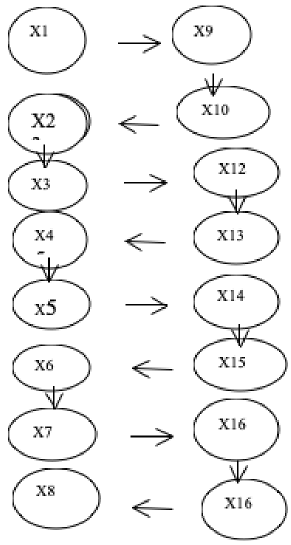

Fig.2 step find the input partition matrix

Step 1:
Looking for fitness X1 X1= $\begin{bmatrix} a1,1 & a1,2 \\ a2,1 & a2,2 \end{bmatrix}$
Step 2:
1.Search for fitness value**X9=** $\begin{bmatrix} a1,3 & a1,4 \\ a2,3 & a2,4 \end{bmatrix}$
2.Compare, if X1>X9=X1
Step 3:
Looking for fitnessX2= $\begin{bmatrix} a3,1 & a3,2 \\ a4,1 & a4,2 \end{bmatrix}$
Compare, if X1>X2=X1 and so on.

The square matrix is partitioned over two rows and 2 matrix columns. Furthermore, based on the greatest fitness weight values of each 2x2 matrix (X1, X2, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13, X14, X15, X16). So, the selected X1 (representing input).

Information:
X10 = $\begin{bmatrix} 1 & 0 \\ 1 & 0 \end{bmatrix}$
Search for Fitness Value X1 s/d X16
X1 =-rb+(ra-rb)(g1.2^{-1}+g2.2^{-2}+g3.2^{-3}+g4.2^{-4})

X1 $=-2+(2+2)(1.2^{-1}+1.2^{-2}+0.2^{-3}+0.2^{-4})$
$= -2+(4).(1/2+1/4)$
$= -2+12/4$
$= -2+3$
$= 1.$

So, the weight (W)=1.
y-in=(g1.w+g2.w+g3.w+g4.w).
= (1.1)+(1-1)+(0.1)+(0.1)=2.
Use Bipolar function with threshold

$$f(x = \begin{Bmatrix} 0, & if\ x \le 0 \\ 1, & if\ x > 0 \end{Bmatrix}$$

Information:

- Motor Wheel don't move, if y-in ≤ 0,
- Driving Wheel can move, if $y - in > 0$

y-in= 2, Driving Wheel can move

3.4. Testing

The test was performed with a laboratory matrix.

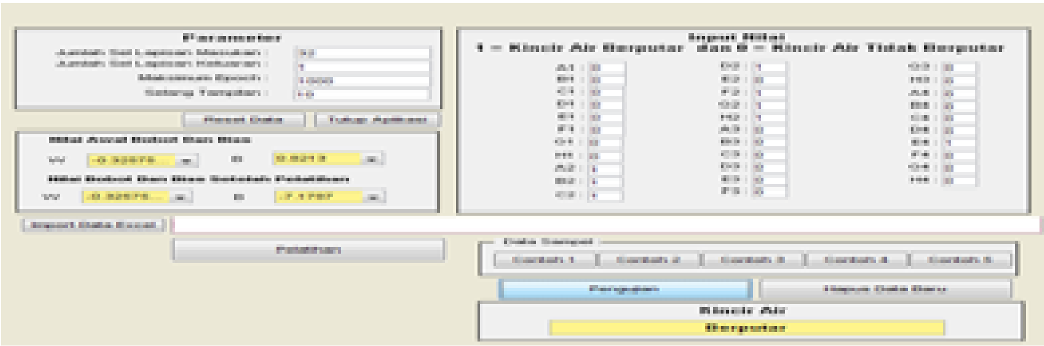

Fig. 3 System for testing the movement of water wheels

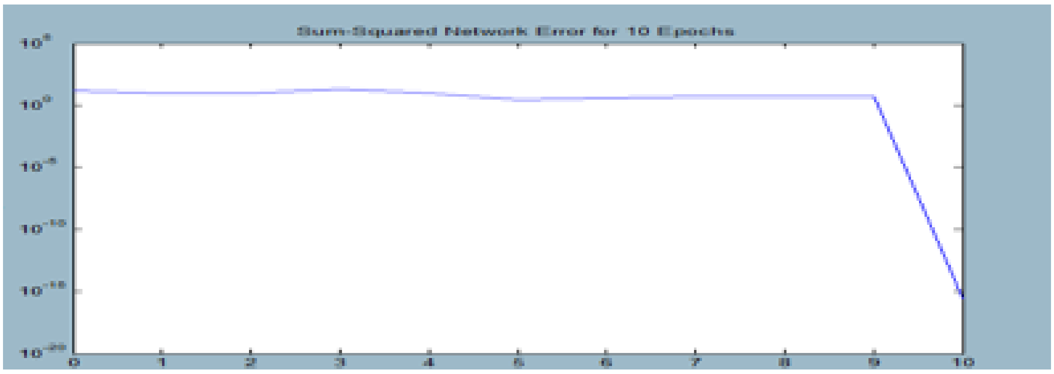

Fig. 4 Training with 10 epochs can recognize the system.

4. Conclusion

The learning process using Genetic Algorithm to find the best weight is more effective to reduce the learning process and more real time. There is a connection between inputs coming in from the variables (dissolved oxygen, water pH, salinity and water temperature) with resulting in the water wheels can move or not. Perceptron Partition is a neural network model that improves perceptron model in the form of learning using Genetic Algorithm approach and partitioned inputs so that characteristic of all input matrix can represent from input matrix value and then system can more real time in pattern recognition.

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