Artificial neural network based particle swarm optimization in predictions mortality rate of broiler chicken

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Abstract. Success in broiler farms can be assessed from the mortality rate of chickens and also a solution to reduce the mortality rate of chickens. But in the process there are obstacles that is the death of hickens that tend to fluctuate so that of course resulted in financial losses for farmers. To prevent it required a method that can predict and control the mortality rate of broiler chickens. In this research, data mining method used is Artificial Neural Network (ANN) based on Particle Swarm Optimization (PSO), to produce accurate prediction with excellent iteration and also small error rate. The results of analysis in predicting mortality rate of broiler chickens by artificial neural network method in combination with Particle swarm optimization get better RMSE result (0.135) than Artificial Neural Network have not been optimized (0.381) with january mortality data and result of application quisioner made value 83,125 which can be categorized well and enough help the farmer in controlling prediction of chicken mortality rate broiler.

Keywords: artificial neural network, mortality rate, particle swarm optimization

1. Introduction

PT. Jafpa Comfeed Indonesia, Tbk Kalapa Nunggal 2 farm unit is one of the branches of PT. Jafpa Comfeed Indonesia Tbk is involved in breeding chickens, broilers, laying hens with a population of approximately 50,000 chickens. The large number of chicken populations, on the other hand, resulted in significant death. So that it can cause some losses such as in terms of financial, time, human resources etc. The company is trying to keep the death rate to a minimum. This is because the condition of each farmer has difficulty in handling conditions that are fast and efficient. The company wants the death rate to be kept to a minimum of around 10% of the total deaths, so as to reduce losses in financial terms.

In figure 1 can be seen that there is a problem that the number of uncertain mortality even in the second quarter of 2015 decreased chicken mortality, but a few months after the death of chicken increased significantly.

The method to be used is Particle Swarm Optimization (PSO) Neural Network (ANN), to produce accurate prediction value with excellent iteration and also small error rate. Prediction on back propagation neural network in the training and validation process to produce a percentage of 100% with one hidden layer architecture, the optimal parameters MSE = 0.0001, learning rate = 0.9, momentum = 0.4. As for the prediction of learners' achievements in the fuzzy inference system mamdani method by using S curve and bell curve (PI curve) to produce a percentage of 83.8%. [1]. While the method for optimization used the PSO method, because it is better than the method of genetic algorithm (GA). Classification accuracy of PSO based SOFM is 93.8 % and classification accuracy of GA based SOFM
is 87.7%. A comparative analysis is performed between the PSO and the GA optimization technique for abnormal retinal image classification. A 5-10% increase in classification accuracy is obtained for the PSO based technique over the GA based technique. The computational time period is reduced by 50% for the PSO based technique when compared with the GA based technique. [2]. It is expected that the PSO-based ANN method can be more accurate with a small RMSE value in predicting mortality rate of broiler chickens.

Therefore, with this method may provide a solution to control the chicken deaths are likely to increase, especially hen. As well as cause exists can be avoided. In addition it can control the mortality of chickens that tend to fluctuate and lead to more dead chickens compared with live chickens. So this condition is certainly very detrimental, especially the management.

This study can contribute to the management in predicting mortality rate of chicken and the factors causing death, so it is expected to take preventive measures early and can avoid the cause of death of chickens. Beside that, it can significantly increase profits for the company in the future because of the reduced death of the chicken.

2. Literature Review
Mohd Khalid Awang, Fadzilah Siraj (2013) conducted a study entitled "Utilization of Artificial Neural Networks in Prediction of Heart Disease". The problem under study is In addition to developing quality of life, increasing the economic burden of individual cardiovascular, family and community, and reducing the productivity of the State. Collection of data used as variables that most influence predictions, costs, and risks. Premature, smoking, cholesterol, hypertension, diabetes mellitus, hypercholesterolemia. The method used for Artificial Neural Networks that produces the best network model produces a predictive value of 88.89 percent. In addition, computer networks in medical diagnosis, this study also shows that brain tissue can be incorporated into the hospital information system as a predictor [3].

Abhijit Suresha, K.V Harisha, N. Radhikaa (2015) conducted a study entitled "Particle swarm optimization over back propagation neural network for the duration of prediction". Collection of data used in this study Input data obtained from the Index, the Main, and the Charlson Index. Special skills include categories such as Surgery, Internal and Emergency. Where this data is to predict the mortality of patients with co-morbid conditions. They compared the Artificial Neural Network with Partic Optimization Optimization Method which is a part that uses Particle Swarm Optimization (PSO) techniques compared to training for training. The algorithm evaluated based on the convergence of
errors, sensitivity, specificity, value of precision and accuracy and the corresponding results are presented. Where there is an increase in the accuracy value of the ANN results optimized by PSO [4].

Reza Gharoie Ahangar, Mahmood Yahyazadehfar, Hassan Pournaghshband (2010) in their journal entitled “The Comparison of Methods Artificial Neural Network with Linear Regression Using Specific Variables for Prediction Stock Price in Tehran Stock Exchange” suggests that the Artificial Neural Network method is better and faster than the Linear Regression method because the Artificial Neural Network method can run parallel calculations and tolerate more errors and also this network can create rules without an implicit formula [5].

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KienEe Lee, Izzatdin bin Abdul Aziz, Jafreezal bin Jaafar (2017) in their journal entitled “Adaptive Multilayered Particle Swarm Optimized Neural Network (AMPSONN) for Pipeline Corrosion Prediction” in their research suggests that the results have also revealed that the AMPSONN method shows a better performance even when the topologies of all methods are optimized, and when the size of training set is reduced. The adaptive multilayered PSO approach has proven itself to be a promising solution to target various individual damage mechanisms and it is also possible to use more datasets in the testing of the AMPSONN method to prove its effectiveness in other application areas [7].

Somayeh Yavari, Mohammad Javad Valadan Zoej, Mehdi Mokhtarzade, Ali Mohammadzadeh (2012) in their journal entitled “Comparison of Particle Swarm Optimization and Genetic Algorithm in rational function model Optimization” suggests that the results proved that both GA and PSO are able to determine the optimal terms of RFM to achieve rather the same accuracy. However, PSO shows to be more effective from computational time part of view. The other important achievement is that the algorithms are able to solve the RFM using less GCPs with higher accuracy in comparison to conventional RFM [8].

2.1. Framework of thinking
3. Methodology
In this research used two methods that support each other is Particle Swarm Optimization Neural Network.

3.1. Step one with Artificial Neural Network [9]
For each input unit \( x_i, i=1,2,3,\ldots,n \) receive signal \( x_i \) and pass the signal on the layer above it (hidden layer). Every hidden layer \( z_j, j=1,2,3,\ldots,p \) adds weighted input signals:

\[
_z \_in_j = v0_j + \sum_{i=1}^{n} x_i v_{ij}
\]  

(1)

Use the activation function to calculate the output signal \( z_j = f(z \_in_j) \) and send the signal to all units in the top layer (output units). For each output units \( y_k, k=1,2,3,\ldots,m \) calculate weighted input signals:

\[
y \_in_k = w0_k + \sum_{j=1}^{p} z_j w_{jk}
\]  

(2)

Use the activation function to calculate the output signal \( y_k = f(y \_in_k) \) and send the signal to all units in the top layer (output units). For each output unit \( y_k, k=1,2,3,\ldots,m \) receiving target patterns connected with the learning input pattern. Then calculate the error information.

\[
\sigma_k = (t_k - y_k) f'(y \_in_k)
\]  

(3)

Then calculate the weight correction (which will be used to fix \( w \_k \) value):

\[
\Delta w_{jk} = \alpha \sigma_k z_{ij}
\]  

(4)

also calculate the bias correction (which will be used to fix \( v_0 \) value):

\[
\Delta v_{jk} = \alpha \sigma_k
\]  

(5)

send \( \sigma_k \) to the units in the bottom layer. Each hidden units \( z_j, j=1,2,3,\ldots,p \) calculate the delta units (from units in the top layer):

\[
\sigma \_in_j = \sum_{k=1}^{m} \sigma_k w_{jk}
\]  

(6)

multiply this value with derivative from its activation function to calculate information of error:

\[
\sigma_j = \sigma \_in_j f'(z \_in_j)
\]  

(7)

also calculate the bias correction (which will be used to fix \( v_0 \) value):

\[
\Delta v_{jk} = \alpha \sigma_j x_i
\]  

(8)

also calculate the bias correction (which will be used to fix \( v_0 \) value):

\[
\Delta v_{0j} = \alpha \sigma_j
\]  

(9)

Each output unit \( y_k, k=1,2,3,\ldots,m \) improve bias and weight \( j=0,1,2,3,\ldots,p \). \( w_{jk} \) (new) = \( w_{jk} \) (old) + \( w_{jk} \) for each hidden layer \( z_j, j=1,2,3,\ldots,p \) improve bias and weight \( i=0,1,2,3,\ldots,n \)
\[ v_{ij}(\text{new}) = v_{ij}(\text{old}) + \Delta v_{ij} \] (10)

Test condition stopped [10].

3.2. Step two with particle swarm optimization
Where: \( X \) = particle position, \( V \) = particle velocity, \( w \) = weight of inertia, \( c1 \), \( c2 \) = acceleration coefficient, \( P \) = number of particles in swarm. The values of \( r1 \) and \( r2 \) are arranged so that the random value is intended to provide stochastic properties in the cognitive component and social components. This stochastic nature causes each particle to move in a semi-random way, strongly influenced in the direction of the best solution of the particles and the best globalsolution of swarm [11].

3.3. Step three software testing with SQA
There are three points of understanding of software quality, including as follows: (1) software requirements are the foundation from which quality is measured; (2) specific standards that define development criteria that guide the manufacture of a software; (3) there are implicit needs often overlooked (eg, desire for the best maintenance); and (4) scores of responder = \( \text{<audibility score>} \times 0.10 + \text{<scoreaccuracy>} \times 0.10 + \text{completeness score} \times 0.15 + \text{<errortolerance score>} \times 0.10 + \text{<score execution efficiency>} \times 0.10 + \text{<operability score>} \times 0.15 + \text{<Simplicity score>} \times 0.15 + \text{<learning score>} \times 0.15 \) Evaluation based on criteria /average score of respondents [12].

4. Results and discussions

4.1. ANN Method

4.1.1. Dataset. The dataset used for this study is data on the death of broiler chickens PT. Jafpa Comfeed Indonesia Tbk unit kalapanunggal 2 from 2014 to 2017. The analysis process that predicts the mortality of broiler chickens for 2018 using the average data from 2014 to 2017 is reduced by 10% and the prediction for 2019 using 2018 data minus 10% in accordance with requests from management.

4.1.2. ANN Model. ANN model used is a backpropagation model which means a method that minimizes errors in output generated by the network. In Figure 3 below is the input unit setting, hidden layer and output on backpropagation. The hidden layer is used as much as 2 hidden layers. Input data is monthly data from chicken mortality data for the period 2014 to 2017 while the output unit is prediction data.
In this study the settings used for artificial neural networks are 500 for training cycles, 0.1 for learning rates, and 0.5 for momentum. For configuration settings used for artificial neural networks as shown in the figure 4 below.

![Figure 3. Configuration ANN formed.](image)

4.1.3. PSO-based neural networks. The configuration for the Artificial Neural Network method is based on Particle swarm optimization (PSO) which can be seen from the picture below:

![Figure 5. Particle swarm optimized neural network configuration.](image)

4.1.4. Comparison between ANN and PSO-based ANN. The RMSE results obtained from this study using artificial neural networks and artificial neural networks with PSO can be seen in figure 6 below:
If seen from table 1 above it can be concluded that the results of ANN + PSO RMSE obtained less than the results obtained from the RMSE ANN shows that the RMSE from ANN + PSO can optimize the RMSE value obtained from ANN. For more details, see figure 7 below:

**Figure 6.** Comparison of RMSE.

|                | JST     | JST + PSO |
|----------------|---------|-----------|
| Januari        | 9,710   | 7,199     |
| Februari       | 8,767   | 3,549     |
| Maret          | 0,785   | 0,589     |
| April          | 13,141  | 2,870     |
| Mei            | 2,583   | 0,493     |
| Juni           | 0,730   | 0,223     |
| Juli           | 1,028   | 0,227     |
| Agustus        | 8,017   | 1,467     |
| September      | 14,115  | 2,296     |
| Oktober        | 5,737   | 1,115     |
| November       | 4,198   | 0,612     |
| Desember       | 5,854   | 2,032     |

4.1.5. **Prediction result data.**

**Figure 7.** Comparison graph of RMSE results.
In this study, the analysis process that predicted broiler mortality for 2018 using the average data from 2014 to 2017 was reduced by 10% and the prediction for 2019 using 2018 data was reduced by 10% in accordance with the request from the management.

4.1.6. Implementation of the system. There are two diagrams presented use case diagram and class diagram.

![Use case designed](image)

**Figure 8.** Predicted data.

| Target 2018 | Prediction 2019 | target 2018 | Prediction 2019 |
|-------------|-----------------|-------------|-----------------|
| Januari     | 205             | 220         | 198             | 206             |
| Februari    | 306             | 319         | 287             | 295             |
| Maret       | 301             | 299         | 269             | 256             |
| April       | 343             | 364         | 328             | 342             |
| May         | 194             | 198         | 178             | 179             |
| June        | 150             | 151         | 136             | 135             |
| July        | 122             | 123         | 111             | 110             |
| August      | 505             | 517         | 465             | 468             |
| September   | 253             | 275         | 248             | 260             |
| Oktober     | 297             | 306         | 275             | 285             |
| November    | 344             | 336         | 302             | 314             |
| Desember    | 322             | 332         | 299             | 301             |

**Figure 9.** Use case designed.
4.1.7. Interface created.

![Image](image.png)

**Figure 10.** Class diagram created.

4.1.8. Interface created. To ensure that the software is created by SQA (Software Quality Assurance) method.

\[
\text{Score} = (85 \times 0.125 + 82.6 \times 0.125 + 83.4 \times 0.125 + 82 \times 0.125 + 81.8 \times 0.125 + 85.6 \times 0.125 + 87.4 \times 0.125 + 77.2 \times 0.125).
\]

The resulting average score is 81,625, while the optimal value for a software that meets the quality standards based on the SQA test is 83.125.

4.2. Discussions

In this study, the analysis process that predicted broiler mortality for 2018 using the average data from 2014 to 2017 was reduced by 10% and the prediction for 2019 using 2018 data was reduced by 10% in accordance with the request from the management. While the application used in the calculation method is Rapidminer 5 with the settings used for Artificial Neural Networks, there are input units, output units
and 2 hidden layers, 500 for training cycles, 0.1 for learning rates, and 0.5 for momentum and at optimize with the particle swarm optimization method. The RMSE results obtained from the method of artificial neural networks with backpropagation model based on particle swarm optimization are 5,854 (December), this is better than the results obtained from the artificial neural network method with backpropagation model before optimization is 2.032 (december). It can be seen from Figure 4.3 that the results of RMSE ANN + PSO are better than ANN before optimization. In addition to the results from RMSE, it was also predicted that broiler chickens would die for the coming year, which is the result of predictions from December that reached 332 broiler chickens mortality for 2018, 301 mortality for 2019. After getting the RMSE results and prediction results, then input into an application implemented with Delphi 7 which is designed to predict the death of broiler chickens to facilitate users in operation. With Admin to process application user data, User or Application user (Employee) who is tasked to input chicken death data, prediction data, RMSE results data obtained from calculations using Rapidminer 5 and Manager who can see and control all systems then there was an application test with the SQA method by distributing the quisioner to the relevant staff.

5. Conclusions
For accuracy and error resulting from the Neural Network method in predicting the mortality rate of chicken boiler, it was 5.854 (december). While the average RMSE results obtained from the method of artificial neural networks which is 6,222 each month. Existing data cannot affect the RMSE results obtained as evidenced by the results of the RMSE obtained in September is the highest result that is equal to 14.115 while the lowest results can be seen in June that is equal to 0.730. While the RMSE results obtained from the method of artificial neural networks with backpropagation models are enhanced by particle swarm optimization which is 2,032 (december). For the average RMSE obtained is equal to 1.889 better by 4.3% of the neural network method with the backpropagation model before being optimized. With the highest RMSE of 7.119 and the lowest RMSE of 0.223. And by using an application that can run the Neural Network method based on Particle Swarm Optimization and with the results of predictions with a good level of error and accuracy and the results of the application test from the management to the audience with the SQA results obtained that is equal to 83.125 this shows that the management is helped with this application and also take the steps needed to prevent mortality of broiler chickens from the prediction of ANN and PSO methods.

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