An optimized model for classification of appropriate technology products using neural networks and genetic algorithms

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Abstract. The background of this research is the difficulty faced when classifying the result of the assessment in the event Competition Appropriate Technology Tegal City. In this paper, the classification result of the assessment is carried out by categorizing the result of technology product that are suitable for implementation in small to medium industries by using the model. The model proposed in this study is using the Neural Network (NN) method to be able to classify products whether into appropriate technology for small/medium industries. Neural Network can produce a low level of accuracy, but Neural Network optimized based on Genetics Algorithm can produced a level of accuracy more higher than without optimization. The genetic algorithm (GA) is proposed to optimize the value of Neural Network parameters such as the number of hidden layers and learning rates. Based on the results of the experiments that have been produced, and system validation using the 10 Fold cross-validation trial shows that the Neural Network method that optimizes the genetic algorithm produces an accuracy rate of 91.37%, better than the Neural Network method without optimization which is equal to 90.14%.

1. Introduction

Innovation in technology will certainly give a significant contribution to the development of this technology. The technology development, especially appropriate technology, is urgently needed at this time both by industries and governments institutions, so that all efforts are made to realize it, one of which is by competing with the appropriate technological innovation competition both by industries or government institutions [1], this has a goal to increase the economy [2]. The event competition has a title Appropriate Technology (Teknologi Tepat Guna /TTG) in Tegal City, Indonesia, has aimed to show the superior products in Tegal City, so that can improve the economy Tegal City. Tegal City has a great economy potential, some of superior products of Tegal’s City include metal, batik, weaving, shuttlecock, handicraft, processes food, and duck eggs where the manufacturing process or craftsmen are mostly still conventional, for this event can bring up creating tools that can help small and middle scale industrial players in Tegal City, both in production and others. Performance in this event (TTG) is very diverse, such as displaying tools that apply modern technology to substitution conventional technology. The difficulties in categorizing related to which tools belong to appropriate technology or not which impact on the difficulty of determining the best value which belongs to the category of appropriate technology. To solve this problem is needs to be classified to classify which categories of appropriate technology or not.
One classification technique is data mining or a technique used to analyze large amounts of data used to classify or make decisions. There are several methods used in the classification of data mining such as Association Rule, Clustering Decision Tree, K-Nearest Neighbour, Neural Network, Link Analysis, Regression, Other heuristic methods [3]. There are other methods, some methods used to classify data such as used linear discriminant analysis, Naive Bayes, SVM, Discriminant Partial Least Squares (DPLS), Procrustes Discriminant Analysis (PDA), Regression Tree, Probabilistic Neural Network and the others.

Neural Network has the ability to be able to do learning based on data used to exercise, to be able to self–organization or to representation of the information received and has real-time operation and to be able to calculations in parallel and have high fault-tolerant [4][5], and also its ability to do modeling to pattern recognition [6]. The Genetic Algorithm is a reliable method so that can be able to determine the optimal value of control parameters for the process. Genetic Algorithm has several advantages, it can be used for discrete or continuous variables, can be used to a big variable, in the final result is some optimum variables, not just a solution, optimization is done by coding the variables and can be used for numerical data, experimental data, or analytical function, such as in optimization parameters to classification the data [7][8].

In this study proposed a model with Neural Network method by optimization parameters used Genetic Algorithm so can improve the level of accuracy and is expected to accelerate the search process in obtaining the appropriate parameter value and optimal by Neural Network so can produce increased accuracy from classifying product them from the event Appropriate Technology Tegal City.

2. Related Work

There are previous studies conducted by researchers in classifying a product, including S.A. Oyewole and O.O.Olugbara [9]. This research tries to classify a product picture used ensemble machine learning is artificial neural network and Support vector machine based on features 18 colors, the result is Neural Network is produced level accuracy better than before, 87.2%. Another research was applied basis functional and Naive Bayes theory for classifying the hidden piece of informations from the pattern text mining to design product innovation development [10].

The research was conducted to classify ergonomics products using anthropometry in the study using the artificial immune [11]. Besides, further the research is carried out by D.Chen, D.Zhang and A.Liu [12], which in his reasearch classified feature product based on custumers reviews with Intelligent Kano framework, and the same as done by K.Habib, in his research classifying a product [13]. Slightly different research conducted by A.Izeta, in that reasearch classified procedures for therapeutic health products [14]. Based on the previous studies, this research proposed a hybrid method Neural Network by opitimization Genetic Algorithm to classify product categories based on result of an assessment, in this study doing optimalization in learning rate parameters dan momentum.

3. Methodology

3.1 Dataset of Research

The Dataset in this research is experimental data, the dataset from the result of assessment in the competition event Appropriate Technology in Tegal City in 2018, include 27 local region technology stall and 4 Posyantek, also from educational institutions in Tegal City.

3.2 Preprocessing Data

It iss the steps to prepare data that has been obtained from the data collection stage, which will be used the following step. The dataset used has several variables which are input where input comes from 10 indicators of assessment.
3.3 Proposed Method,
In this step will discuss the methods that will be used in research. Evaluation and Validation of this research, this step discusses the result of validation from the experiments used K-Fold Cross Validation, can be depicted at Figure 1.

![Proposed Model Diagram](image)

**Figure 1.** Research Methodology

4. Result and Discussion
To get an appropriate model that is follow with what is expected in this study two steps were carried out, using a Neural Network and experiments using a Neural Network (NN) optimized with Genetic Algorithm (GA).

4.1 Result best Model
For experimental models with Neural Network, several experiments have been carried out including:

- Determine the number of training cycles, to determine the number of the best training cycles, the experimental is used the number training cycles from 100 until 500, with the result this experiment has produced the best accuracy at training cycles 500 and level accuracy 82.50%.
- Determine the number of Neuron at Hidden Layer, to determine the number of neuron at hidden layer conducted several experiments to get the best in this experiment using 500 training cycles. By default in this experiment using parameter 0.3 learning rate dan 0.2 for momentum, the best accuracy 86.25% and the number of neurons are 2.
- Determine Parameter Learning Rate, the value of learning rate selected based on the best accuracy has result 90.14%. Based on the result of the experiment above, select the learning rate at 0.4.
- Determine Parameter Momentum, to determine value of momentums select based on the best accuracy is the highest from the experiments, at 90.14%, based on the experiments the value of momentum at 0.1.

| Table 1. Parameter | Value     |
|--------------------|-----------|
| Parameters         | Value     |
| Input (neuron)     | 10        |
| Output (neuron)    | 4         |
| Training Cycles    | 500       |
| Hidden Layer / neuron | 1/2 neuron |
| Learning rate      | 0.4       |
| Momentum           | 0.1       |
| Accuracy           | 90.14%    |
Experiments with Neural Network produce accuracy of 90.14% by rules in Table 1. The next experiment is doing optimization model, in the other side experiment with Neural Network optimized Genetic Algorithm get the best accuracy of 91.39% by rules at Table 2.

### Table 2. Parameters the best result with optimized GA

| No | Parameters               | Value               |
|----|--------------------------|---------------------|
| 1  | Max generations          | 50                  |
| 2  | Population size          | 5                   |
| 3  | Mutation type            | Gaussian_mutation   |
| 4  | Selection type           | Roulette wheel      |
| 5  | Crossover prob           | 0.9                 |
| 6  | Neural Net.learning_rate | = 0.2398029493270926 |
| 7  | Neural Net.momentum      | = 0.9748796206595816 |
| 8  | Accuracy                 | 91.39%              |

### 4.2. Evaluation Model

Based on analysis of testing between the Neural Network model with Neural Network optimized Genetic Algorithm, so the result can be depicted in Table 3 and Figure 3.

### Table 3. The analysis result between NN with NN based on GA

| No. | Parameters | Neural Network (NN) | Neural Network (NN) – Genetic Algorithm (GA) |
|-----|------------|---------------------|---------------------------------------------|
| 1   | Learning rate | 0.4                | 0.2398029493270926                           |
| 2   | Momentum    | 0.1                 | 0.9748796206595816                           |
| 3   | Accuracy    | 90.14%              | 91.39%                                       |
Build up on the analysis result from this study can be seen that there is an influence from optimizing the determination of Neural Network by Genetic Algorithm (GA), who succeeded in increasing level of accuracy, is increasing the level of accuracy of 1.25% from 90.14% to 91.39%. Therefore to optimizing Genetic Algorithm on the Neural Network is an increase in accuracy, has succeed increasing the level accuracy.

5. Conclusion
The increase can be seen from the increasing of level accuracy with Neural Network model, from level accuracy of 90.14%, after optimization the level accuracy of Neural Network build upon Genetic Algorithm get the level accuracy at 91.39%, more increase than before optimization, this is proven that there influence the level accuracy of 1.25%.

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**Figure 3.** Evaluation model graph
with ensemble machine learning,” *Egypt. Informatics J.*, vol. 19, no. 2, pp. 83–100, 2018.

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