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Comparison of ReLu Activation and Logistics Functions in Classification of Casting Product Defects with Perceptron Multilayer Approach

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A B S T R A C T

In the industrial sector, production quality is very important for company operations and must be managed effectively. ISO 9001 emphasizes quality management to direct processes and improve organizational efficiency. Quality control is important to prevent defects in materials, because foundry production must produce high quality materials so that they can be used in the long term. ISO 14001 environmental management environment, with high output impacts on the environment due to lack of transparency. This research uses ReLu and Logistics Activities to improve casting quality using multilayer perceptron technology, finding that ReLu activities have a higher dominance (99%) compared to other actives.

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INTRODUCTION

Product quality is crucial during the production process, and identifying defects is essential to avoid losses and maintain customer confidence. Simulated neuronal networks (JST) are computer science algorithms trained to perform functions such as taking, modeling, and storing human intelligence in information systems for decision-making. JST has many layers of neurons interconnected, including the input, secret, and output layers. The signal runs through a coupling connection, called a neuron, with each neuron having an appropriate weight to double or double the signal sent through it. Each neuron uses an activation function to add a weighed input to the received signal to determine its output signal. This classification determines whether goods are qualified or not to proceed to a further process. In the industrial world, inspection processes are carried out with direct vision senses, and there is a different perception comparison between inspectors.

Indonesian manufacturing production has risen rapidly, with the metal casting industry entering the base metal sector by 9.92%. The main problem is dependence on imported materials and machine acquisition. The development of lost foam investment casting combines modern and traditional casting processes, such as sand casting, foam casting lost, investment casting, and dead casting. This experimental study aimed to determine if foam-free casting produced better casting results using pre-experimental methods and whole group comparison models. Two casting tests were conducted, one using the sand casting technique and the other using foam expansion casting technology lost. After the casting process was completed, the results were evaluated to identify errors in the process.

This research focuses on the performance of Multilayer Perceptron (MLP) algorithms in prediction and classification problems. Out of 30 benchmarks, 5 out of 30 research papers state the MLP algorithm's performance as excellent, with 25 out of 30 papers declaring it efficient. The lowest performance of the multilayer perceptron algorithm was 62.89% in 14 scientific papers, while the highest performance was 100% for the mult Layer Perceptron algorithm. The average performance of a multilayer perceptron algorithm is 91.98%, which is only 8.02% lower than the maximum possible performance of 100%.

A study by [5] compared ReLu and Tanh activation functions on the MLP, highlighting the importance of neural networks in machine learning. The study examined eight models to classify Titanic crossing collections by changing the number of hidden layers and neurons present in each Hidden Layer. The results showed that Tanh activation function was less accurate and accurate than ReLu function. The larger number of concealed layers did not improve classification results. Models with ReLu activation functions with four Hidden Lays and fifty neurons on each Hidden Layer had the highest accurate values, while models with four Hidden Layers had higher values.

A study by [6] aimed to develop a vector machine support algorithm (SVM) with two types of kernels: Radial Base Function (RBF) and Linear, which can be used to predict defects in casting products. This research improves the quality of production in the casting industry by producing a prediction model that accurately detects possible defects on casting products and converts casting quality data into numerical data for accurate classification.
The research aligns with previous research on the comparison of ReLu and Logistic activation functions in classifying defects of casting products using the MLP approach. Perceptron's multilayer algorithm was used in this study due to its effectiveness in classification problems.

LITERATURE REVIEW

Neural Network

Simulated neural networks (JSTs) have a rich history, dating back to the 19th century, with early concepts originating in the 19th century. Early development began in the 1940s with simple models like McCulloch-Pitts Neuron and Perceptron, and the first attempts to build learning models. The development of JST fell backwards in the 1960s and 1970s due to technological constraints and limited understanding of biological neural networks. However, in the late 1980s, interest in neural networks re-emerged due to new learning algorithms like backpropagation. Modern Era (2000s to present) saw JSTs reach its peak with advancements in computer technology, increased computing capacity, and machine learning algorithms. These networks have become crucial in artificial intelligence and machine learning, with applications in fields like image recognition, automated language translation, and robotics. Innovation and research continue to open new possibilities in JST use and development. Neural Network is a computing model inspired by human biological nerve tissue, consisting of connected neurons that learn from data. It consists of three main layers: the input layer, hidden layer, and output layer. The input layer inserts data, with each neuron representing features. The hidden layer, between the input and output layers, extracts relevant features by performing mathematical operations on the input. The output layer, the final layer, processes the prediction or processing process. The number of neurons in the output layer depends on the task type, such as binary classification, where two neurons represent different probability classes.

Neurons have activation functions to determine their activity based on input. Common activation functions include ReLU, Sigmoid, and other functions like tanh. Training process improves learning by providing training data with input-output variance. Internal parameters (bobot and bias) are optimized using algorithms like backpropagation to reduce bias and optimize parameters. Training data can be used for classification, regression, polynomial analysis, and new content generation like random or text.

Classification

Classification on activation functions is a method used in machine learning to divide objects or data into different categories based on certain characteristics. It involves using a mathematical function applied to the output of each neuron in a simulated neural network, allowing the network to study complex representations of input data and make classification decisions. Classification is a common task in machine learning, where models are trained to study patterns from given training data and then used to predict classes from new data that are not yet visible. In the context of neural networks, classification is a common application of the nerve network, and various network architectures can be used for classification tasks. The process involves model training using labelled training data, studying the relationship between input features and label-output. After training, the model can predict a class or label that matches new data that is not yet visible.

ReLu (Rectified Linear Unit)

The ReLU function (Rectified Linear Unit) is one of the most commonly used activation functions in replicated nerve tissue, including for product classification. ReLU is defined as:

$$f(x)=\max(0,x) \quad \text{(1)}$$

The Rectified Linear Unit (ReLU) function is a widely used activation function in duplicated neural tissue, particularly for product classification. It is a low-cost, basic function that solves "vanishing gradients" issues, which are common with other activation functions like sigmoids and tanhs. ReLU's linear behavior towards positive values allows for faster learning due to its ability to avoid small gradients. Despite its affordability and ease of use, ReLU has some drawbacks, such as "dying ReLU," which occurs when neurons stop firing during training if their gradients are consistently zero. Variations on ReLU include Leaky ReLU, Parametric ReLU (PReLU), and Exponential RELU (ELU). Despite these disadvantages, ReLU remains a popular and practical choice in many situations, including product classification, due to its affordability and ease of use.

Logistic

A sigmoid function, or better known as a logistical function, is an activation function commonly used in replicated neural networks, especially in the case of binary classifications :

$$f(x)=1+e-x1 \quad \text{(2)}$$

Sigmoid is a function that generates a positive probability between 0 and 1, which can be understood as a positive coefficient in a binary classification problem. Some sigmoid functions are interpretable: output sigmoid can be understood as a positive coefficient in binary classification, while non-linear functions allow smooth connections between input and output.

METHOD

The method adopted in this study consists of a number of steps aimed at developing and evaluating existing data to be classified using neural networks using ReLu and Logistic functions. Each step is designed to ensure that the data processed is properly, the model is trained effectively and efficiently, for the required results so that they are accurate and reliable.

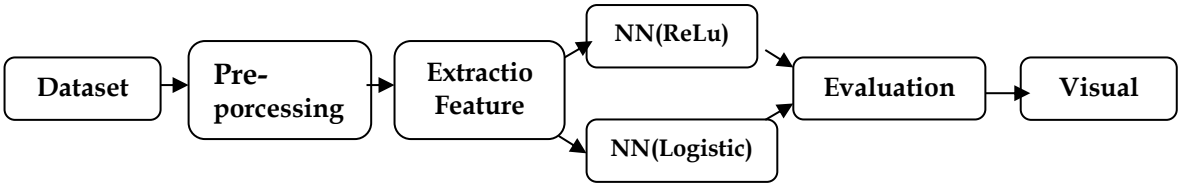

Figure 1. Conceptual Framework

RESEARCH RESULT

Dataset

The data used for this study are diagram images compiled and used to test the ability to activate a simulated neural network. As shown in Figure 2, there are two types of product conditions that are classified, namely good products and bad products.(cacat). The image material collected comes from the Internet, namely Kaggle which is then merged into the onedrive dataset to be then processed and customized as needed.

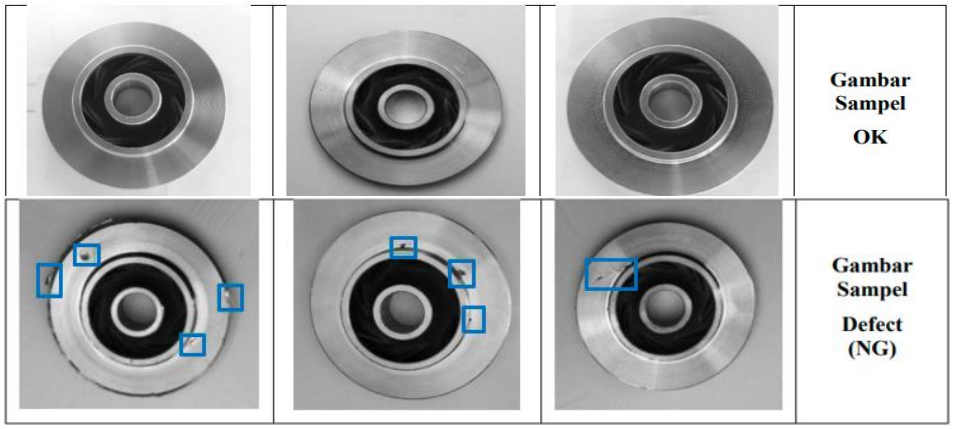

Figure 2. Sample Product

Pre-processing

Conversion of image data to numerical data involves several stages, including image conversion, data processing, modeling, analysis, and evaluation. Drawers are digital devices used in this process, which can be complex depending on the application and purpose of the analysis. Some applications use deep learning techniques for data analysis.

Extraction Feature

The method of compressing data while keeping the most crucial information intact is called feature extraction. It entails choosing characteristics for data processing, which can be accomplished by transformation,

extraction/engineering, and selection. While transformation removes features, extraction/engineering removes features and adds new ones, and selection removes non-essential features. The technique of examining and looking for features on an image in order to identify an object is known as characteristic extraction. The classification procedure uses the feature extraction results as input, along with the classification parameters. Identifying or differentiating items from one another is the aim of feature extraction.

Modelling

Neural Network

Neurons in neural networks use activation functions like ReLu and Sigmoid to determine their activity based on input. Imitation neural networks learn through training processes, where they present a large amount of training data with expected input-output pairs. Internal parameters are updated iteratively using optimization algorithms like backpropagation to reduce prediction errors. With proper optimization and architecture, replicated neural networks can be used for tasks like classification, regression, pattern identification, and creating new content like images or text. These networks can be used for classification, Neural network is a mathematical model inspired by the structure of human biological nerve tissue. Image recognition on neural networks is used in applications such as facial recognition, object detection in images, and image classification. Then it is in this modeling phase the author uses a supporting application to perform simulations related to two activation functions on the neural network, this application is also widely used by some researchers in doing simulations. The application used is Orange, Orange is a visual data analysis platform designed specifically for non-technical users. It provides tools and techniques for data analysis, visualization, machine learning, and decision-making.Orange is very useful for professionals in a variety of fields, including data science, business analysis, research, and education, who want to explore and understand their data quickly without the need for in-depth knowledge of programming or statistics. with the following simulation image :

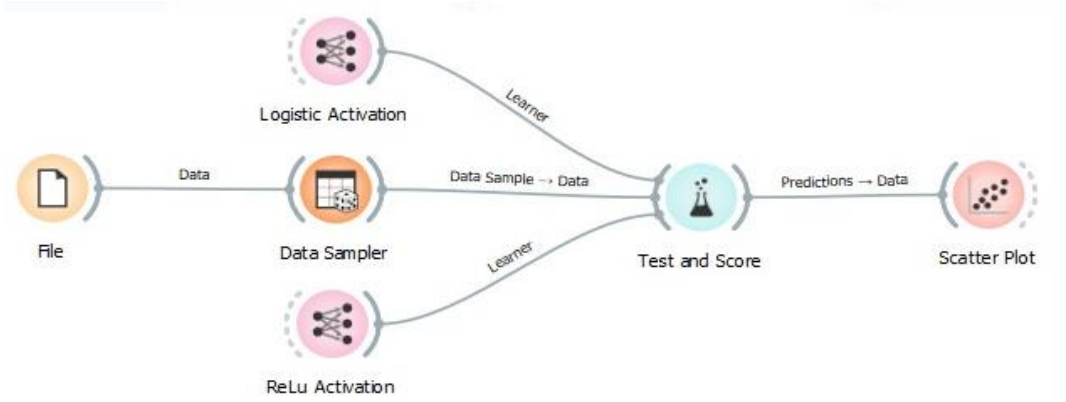

Figure 3. Image simulation with the Orange application

ReLu Activation

In the context of Orange applications, ReLU (Rectified Linear Unit) is one of the activation functions commonly used in neural networks. It is a nonlinear function

that introduces non-linearity into models, which allows networks to learn more complex representations of data. ReLU activation settings in the Orange application usually occur when you build or train a simulated neural network model. Here, you can customize your model parameters and configurations, including activation function types and settings.

The use of ReLU as an activation function in nerve tissue is very common because it is simple, effective, and efficient in the training process. It deals with slow training problems and vanishing gradient problems, which often occur with activation functions such as sigmoids and hyperbolic tangents.

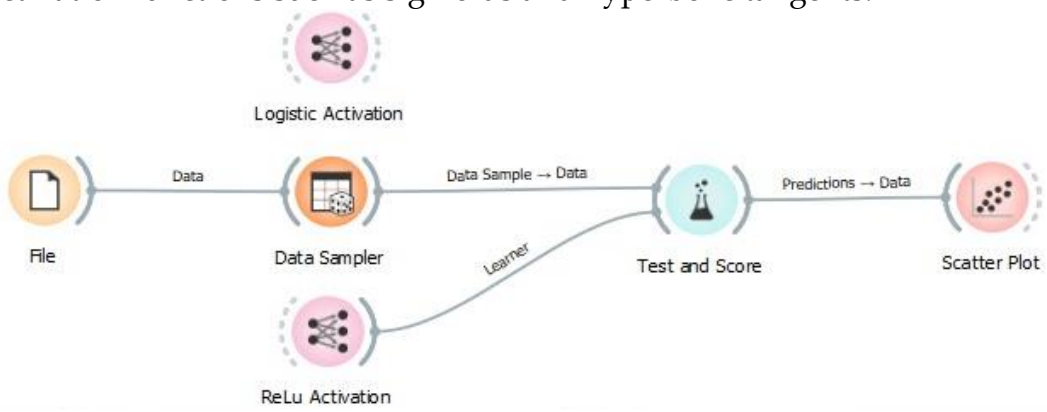

Figure 4. Image simulation with ReLu activations

Logistic Activation

In the context of Orange applications, logistic activation is one of the activation functions that can be chosen when building or training simulated neural network models. The logistic activation function, also known as the sigmoid, converts the continuous input into a range of values between 0 and 1. However, this function also has shortcomings, including a narrow range of values at its extreme part, which can lead to slow training problems and disappearing gradient problems.

While the logistical activation function is still used, especially in the context of traditional binary classifications, in some cases, other activation functions such as ReLU are more commonly used because of their simpler and more efficient nature in the training process.

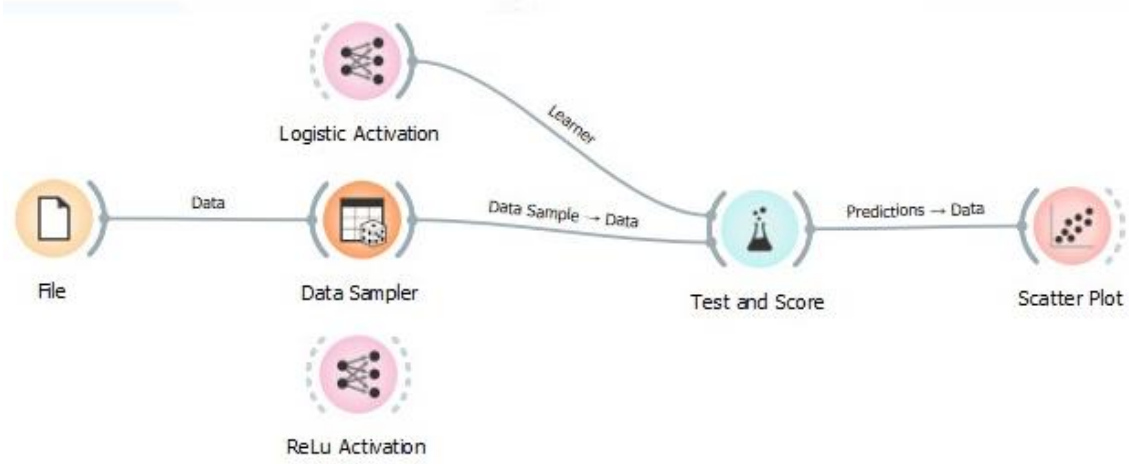

Figure 5. Image simulation with Logistic activations

The author did the same setting on both of these activations, starting with the number of hidden layer neurons, the solver method using Adam, and the maximum number of iterations. by giving the same value to both activations so that we can know how well these two activations function.

Table 1. Setting Item Method

Item	Score
Neurons in hidden layer	100
Activation	ReLu / Logistic
Solver	Adam
Max. Number of Iterations	200

The author did the same setting on both of these activations, starting with the number of hidden layer neurons, the solver method using Adam, and the maximum number of iterations. by giving the same value to both activations so that we can know how well these two activations function. Of the above set of values performed execution and obtained excellent results, with the results of the table below can be seen that the ReLu activation function is better than Logistics. of the evaluation metric items such as AUC (Area Under the ROC Curve), CA (Classification Accuracy), F1-score, Precision, and Recall (Recall or Sensitivity) can be used to evaluate the performance of the classification model. obtained values like tables

Table 2. Result table

Model	AUC	CA	F1	Prec	Recall
Act. Logistic	0.998	0.986	0.986	0.986	0.986
Act. ReLu	0.999	0.990	0.990	0.990	0.990

DISCUSSION

In this simulation, metrics such as AUC (Area Under the ROC Curve), CA (Classification Accuracy), F1-score, Precision (Presisi), and Recall (Recall atau Sensitivity) can be used to evaluate the performance of a classification model. AUC indicates that a good model can cover two peaks with a large area under the ROC curve. CA is a measure of accurate predictions from all samples, but may not be representative if the distribution of samples is not consistent. F1-score is the harmonic ratio of Precision and Recall, indicating the difference between positive and negative predictions. Precision shows the probability of a model's positive results in positive predictions. Recall (Sensitivity) indicates the probability that a good model can match all positive instances. In Orange, users can use the "Classification Evaluation" widget to evaluate and compare metrics after analyzing a classification model. With a suitable evaluation method, users can understand their model's performance better and have a more accurate model for classification problems.

CONCLUSIONS AND RECOMMENDATIONS

From this inquiry, can be seen on the outcome of the value that comes out in determining and calcifying casting goods NG and OK with a simple picture of the case can be used as a reference in carrying out the inspection process. So can help the part of inspection in performing inspection and processing on the product in doing the classification.

ADVANCED RESEARCH

However, there are a few things to do when it comes to NG products of different types, and how fast the visual capture is if this application is actually done in the world of industry, where industry processes are so much in production. Then, this research still needs to be upgraded and funded to bias a larger case. The author needs to get input on the shortcomings of this simple research

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