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Hyperparameter Model Architecture Xception in Classifying Zophobas Morio and Tenebrio Molitor

Amri Ismail Tumanggor[1], Muhathir*[2]
[1]Department of Informatic Engineering, Universitas Medan Area, Indonesia
[2]School of Informatic Technology, Universitas Medan Area, Indonesia

ABSTRACT

Zophobas Morio and Tenebrio Molitor are popular larvae as feed ingredients that are widely used by animal lovers to feed reptiles, birds, and other poultry. However, these two larvae are similar in appearance; their nutritional content is very different. Zophobas Morio is more nutritious and has a higher economic value compared to Tenebrio Molitor. Due to limited knowledge, many animal lovers have difficulty distinguishing between the two. This study aims to build the best configuration of the Xception architecture hyperparameter model that can distinguish between the two. The model is trained using images taken from mobile phones. Training is carried out using the parameters Epoch 15, Batch Size 32, Optimizer Adam, RMSprop, and SGD. The experimental results on the dataset show that the best accuracy for the Xception architecture hyperparameter model is Optimizer Adam with an accuracy rate of 100%, and Optimizer SGD with an accuracy rate of 100%. And of course, it gives very good results.

Keyword : ***Zophobas Morio; Tenebrio Molitor; Deep Learning; Architecture Xception***

Corresponding Author:
Muhathir,
Department of Informatic Engineering
Universitas Medan Area
Jl. Kolam No.1 Medan Estate, 202223, Indonesia.
Email : amritumanggor6@gmail.com

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1. INTRODUCTION

The Deep learning is one of the breakthroughs in machine learning that may be used to categorize photos to assist people in rapidly and accurately recognizing or categorizing objects while handling a large amount of data at once (Maulana & Rochmawati, 2019). Deep learning continues to learn various data representations with different levels of abstraction and employs a number of non-linear tingat units to identify important features in the data that is provided and processed automatically (Khamparia & Singh, 2018).

According to Mayler (Meler, Syben, Lasser, & Riess, 2019) the problem-solving capability of deep learning can also be demonstrated based on previous research including (Ramanath, Muthusrinivasan, Xie, Shekar, & Ramachandra, 2019). One such study focused on deep learning in land cover classification using aerial images, achieving an accuracy of 85.3%. Ferentino (Ferentinos, 2018) onducted a separate study on plant detection using leaf images, utilizing a dataset of 87,848 images encompassing 25 different plant species, with the best performance reaching a success rate of 90%.

To ensure optimal performance in comparing two larvae, namely the Zophobas morio (mealworm) and the Tenebrio molitor, deep learning is employed for object identification and classification. Both the mealworm and the tenebrio molitor share identical morphologies, with the mealworm being more nutritious (Pratondo & Bramantoro, 2022). Due to the morphological similarities between these two larvae, it is challenging for the general public to differentiate them. The mealworm has a slightly higher chitin content compared to the tenebrio molitor, making it a more suitable option as a food source. These larvae are commonly used as feed for reptiles, poultry, and songbirds (Pradana, 2022).

Convolutional Neural Network (CNN), which includes numerous designs, notably Xception, is one of the algorithms frequently employed in deep learning for image categorization. The Xception architecture, a development of the earlier Inception architecture, consists of 36 convolutional layers that form the foundation of feature extraction (Darmatasia, 2020). To minimize temporal and spatial complexity while preserving crucial information, Xception utilizes separable convolutional layers with residual connections (wu, Liu, Yang, & Chen, 2020). The Xception architecture comprises three core components: the entry flow, which contains two blocks of convolutional layers; the middle flow, which repeats eight times; and the exit flow (Soria, Riba, & Sappa, 2020).

The Xception architecture features a deeply separable convolutional network, and significantly outperforms the Inception V3 architecture on larger image datasets comprising 350 million images and 17,000 classes. In terms of parameters, Xception surpasses every model in the ImageNet dataset (Chollet, 2017).

Optimal hyperparameters play a role in enhancing the performance of an architectural model (Farag, Said, Rizk, & Ahmed, 2021). Hyperparameters are variables that specify the structure of a neural network and the learning/training process, enabling a computer or model to estimate or optimize a classification model (wu, et al., 2019).

The Xception architecture was employed in this study because it is a popular component of transfer learning and has demonstrated great success rates, as evidenced by several research findings. One such study utilized transfer learning to categorize Zophobas Morio and Tenebrio Molitor. (Pratondo & Bramantoro, 2022).

2. RESEARCH METHOD

A. Study of Architecture

The collected data is then subjected to preprocessing, where the image size is reduced to prevent the presence of excessively large files. Following this, the training and testing data are separated from the dataset. The design phase is then implemented using the Xception architecture. The data is subsequently trained and tested to obtain training and validation accuracy, which is utilized for categorization and determining the best accuracy result.

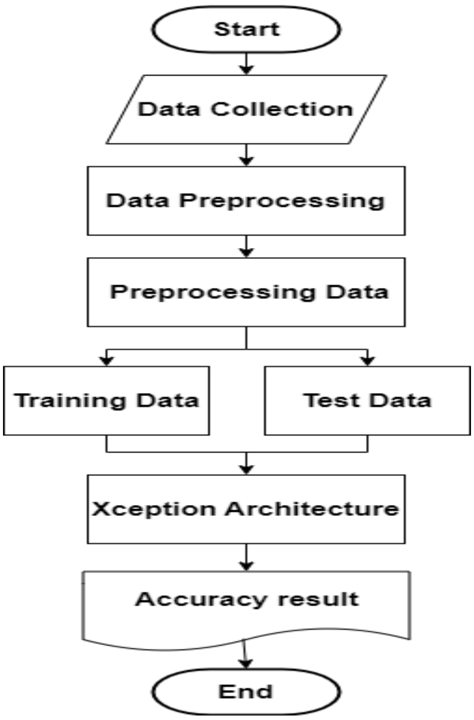

Figure 1. Reasearch flow Picture

B. Data Collection and Data Analysis

A dataset comprising a total of 2000 photos is divided into 1036 images of Zophobas Morio and 964 images of Tenebrio Molitor. The data samples for Tenebrio Molitor and Zophobas Morio were sourced from : https://doi.org/10.6084/m9.figshare.16918873.v1

C. Xception

With input images of size 299x299, the Xception architecture consists of 36 convolutional stages. The images undergo convolution with 3x3 filters using a stride of 2. The original inception modules are replaced with deeply separable convolutions. Xception introduces an extreme hypothesis by incorporating cross-channel correlations (cross-feature maps) and redirecting them to 1x1 convolutions. This is followed by 3x3 convolutions to ensure identical outputs for each feature (Banumathi, et al., 2021).

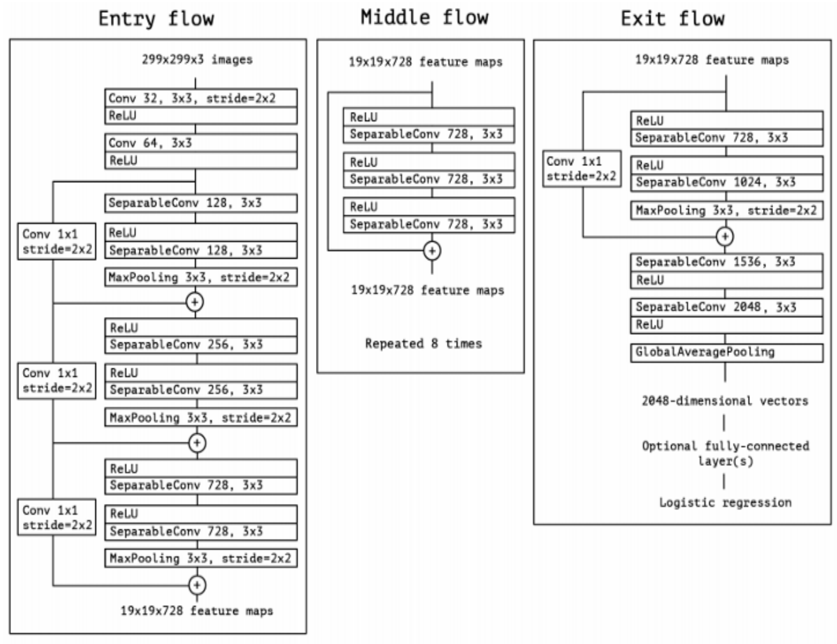

Figure 2. Architecture Xception

The entry flow, the middle flow (looped eight times), and the exit flow are the three main sections of Xception. Each flow consists of several filters and layers (kernel sizes). The sizes of the images, the number of layers, the types of filters, and the connected exit flows are displayed in the middle and exit flows, respectively (Chollet, 2017).

D. Hyperparameter Initialization

In this study, the parameters used were 15 epochs and a batch size of 30. The optimizer parameters utilized were Adam, RMSprop, and SGD.

E. Evaluation

Accuracy, Precision, Recall, and F1 Score are the metrics to be used in evaluating the quantitative performance of the proposed model. To understand the metrics that will be used, it is necessary to first define the terms true positive (TP), false positive (FP), false negative (FN), and true negative (TN) as shown in the confusion matrix table below:

TABLE I. CONFUSION MATRIX

		True Values	
		Positif	False Positive
Prediction	Positif	True Positive	False Positive
	Negatif	False Negative	True Negative

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \quad (1)$$

$$\text{Precision} = \frac{TP}{TP+FP} \quad (2)$$

$$\text{Recall} = \frac{\text{TP}}{\text{TP+FN}} \quad (3)$$

$$\text{F1 Score} = 2 \text{ X } \frac{\text{Precision X Recall}}{\text{Precision+Recall}} \quad (4)$$

Confusion matrix is a visual assessment tool used in machine learning. To list every potential example of a classification problem, the columns of the confusion matrix represent the predictions for the class outcomes, while the rows indicate the actual class outcomes (mohammad, Ghani, Fahrizal, & Lawi, 2021).

3. RESULTS AND DISCUSSION

A. Sample Data

The data used in this study consists of the species Zophobas morio and Tenebrio Molitor. Here are some sample data used for this research.:

(a) (b)

Figure 3. (a) Zophobas Morio (b) Tenebrio Molitor

B. Experiment

The presented experiment results utilized the Xception architecture model and were compared to determine the most suitable parameters for the dataset in this case. The evaluation of the confusion matrix was employed, showcasing the values of the lowest loss and the best validation, which were considered as indicators of the best model. The experiment focused on the parameters with 15 epochs and a batch size of 64, using the Xception architecture model and the optimizer parameters: Adam, RMSprop, and SGD.

C. Training Model Exception Adam Optimizer

The results of training the Xception model with the Adam optimizer show a minor initial gain followed by stability, as seen in Fig. 2. The loss number shows a decreasing trend, demonstrating a low mistake rate and ultimately helping to achieve the highest levels of accuracy.

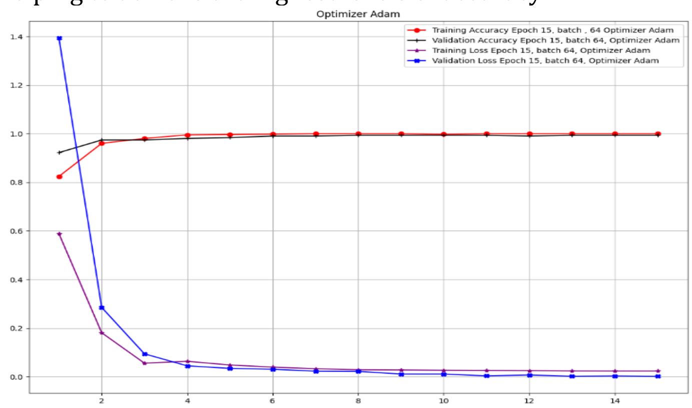

Figure 4. Training Model Xception with Adam Optimizer

D. Training Model Exception SGD Optimizer

Testing with the SGD optimizer shows a training accuracy that tends to stabilize with a slight initial decrease, resulting in good accuracy. This is further supported by a significant decrease in the loss value, indicating a notable reduction.

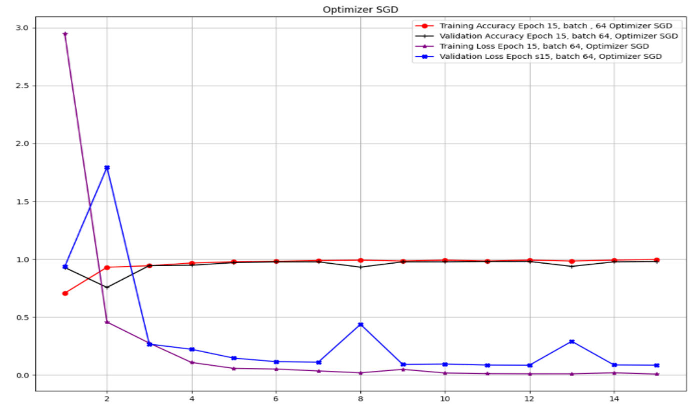

Figure 5. Training Model Xception with SGD Optimizer

E. Training Model Exception RMSprop Optimizer

As shown from the first rising trend in the graph followed by stability until the conclusion, the training results employing the RMSprop optimizer show promising accuracy values. The graph of the loss values shows a downward trend despite variations, indicating strong performance, which finally results in the lowest loss value.

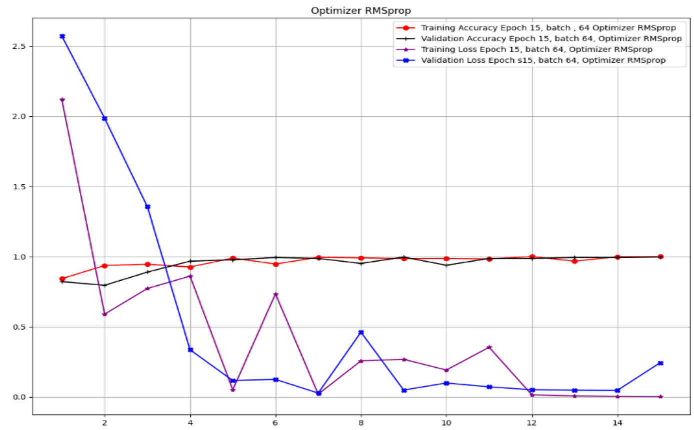

Figure 6. Training Model Xception with RMSprop Optimizer

F. Confusion Matrix

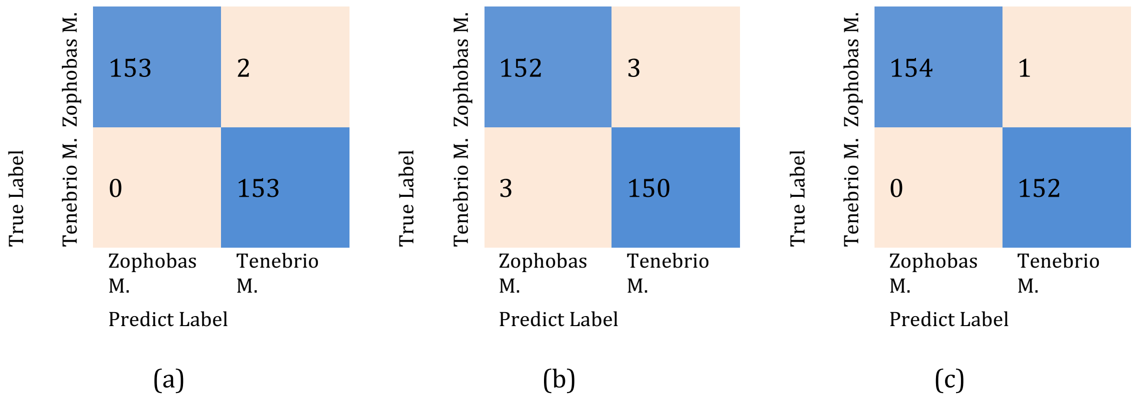

Figure 7. (a)Confusion Matrix Adam (b) Confusion Matrix SGD (c) Confusion Matrix RMSprop

In the confusion matrix shown in Fig. 5.(a) for Adam, 153 instances of Zophobas Morio were correctly recognized, with 2 instances misclassified as Tenebrio Molitor. Additionally, 153 instances of Tenebrio Molitor were correctly identified, and there were no instances misclassified as Zophobas

Morio. In Fig. 5.(b) for SGD, 153 occurrences of Zophobas Morio were correctly recognized, with 0 instances misclassified as Tenebrio Molitor. Similarly, 153 instances of Tenebrio Molitor were correctly identified, and there were no instances misclassified as Zophobas Morio. Moving on to Fig. 5.(c) for RMSprop, 154 occurrences of Zophobas Morio were correctly recognized, with 1 instance misclassified as Tenebrio Molitor. Furthermore, 153 instances of Tenebrio Molitor were correctly identified, and there were no instances misclassified as Zophobas Morio.

G. Performance Measure

TABLE II. PERFORMANCE MATRIX

Model	Optimizer	Accuracy	Precission	Recall	F1 Score
Xception	Adam	0.9945	0.9989	1.000	0.993
Xception	SGD	1.000	0.9997	1.000	1.000
Xception	RMSprop	0.9907	0.9994	1.000	0.9936

H. Discussion

The classification of Zophobas morio and Tenebrio molitor using the Xception model with SGD hyperparameters can provide promising accuracy results, with 100% accuracy, 99% precision, and 100% recall. This achievement is undoubtedly a commendable accomplishment, surpassing previous achievements with the same type of dataset, which consists of Zophobas morio and Tenebrio Molitor larvae. The achievement is presented in the table below:

TABLE III. RELATED WORKS

Related Works	Larva Types	Methods	Results
(Azman & Sarlan, 2020)	*Aegypti, Albopictus, Anopheles,Armigeres, Culex*	Convolutional Neural Network	0.7-73% accuracy
(Asmai et al., 2019)	*Aedes Aegypti*	VGG16, VGG19, ResNet50, InceptionV3	77.31-85.10% accuracy, 0.31-0.66% loss
(Shang, Lin & Cong, 2020)	*Zebrafish*	GoogleNet, VGG19, AlexNet	91-100% accuracy
(Pratondo & Bramantoro, 2021)	*Zophobas Morio, Tenebrio Molitor*	VGG19, InceptionV3	97.2% precision, 96.6% recall, 96.876% accuracy
Ours	*Zophobas Morio, Tenebrio Molitor*	Xception	100% accuracy, 99% precision, 100% recall

4. CONCLUSION

Using the Xception approach and three optimizers (Adam, RMSprop, and SGD), we developed a comprehensive model for classifying Zophobas Morio and Tenebrio Molitor larvae. The experimental results indicate that the Adam optimizer achieves the highest accuracy of 100%. Additionally, both precision and recall have values of 100% and 99%. These findings hold significant potential for practical applications. To further improve this model, future research can explore options such as expanding the dataset and incorporating more advanced model designs.

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