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# Nasi Food Image Classifier: Automated Classification of Multiple Nasi Labelled Images (i.e. rice) using Deep Learning Methods

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***Abstract*—This paper is about how to use deep learning to classify nasi (i.e. rice; Malaysia term: nasi), the paper contains 6 parts, introduction about deep learning, nasi, and how to use deep learning to classify six types of nasi.**
**Literature survey about deep learning, and how to proposed deep learning on recognition for nasi(this contains CNN architecture, VGG16, Xception and ResNet transfer learning model, the dataset which used to train the model and the augmentation, Xception is the best model, it has the highest validation accuracy 96.9% while ReNet has highest test accuracy 96.2%.), the performance result(which contains effects of hyper-parameters of the proposed model, the plot of loss and accuracy of the model, the comparision of classification accuracies of proposed and transfer model ), the conclusion of this project and the future of this model.**
**The basic and the most important thing in this project is to collect dataset and make a classification for nasi which is a type of food that consists mainly of rice.**
**The nasi in this project consists of six types (Nasi briyani, Nasi dagang, Nasi kerabu, Nasi lemuni, Nasi minyak, Nasi tomato, each type of nasi has about 300 pictures, and there are 1800 pictures in total). We consider these six different kinds of nasi as label in this project.**

***Keywords*—Nasi, convolutional neural network, deep learning, transfer learning, VGG16, Xception, ResNet.**

## I. INTRODUCTION

In nowadays world, as the economy growth, people do care about their health, one of the biggest factors is whether the food is nutritious, when we know the type of food, we try to fill the body's need for carbohydrates, proteins and vegetables. Eating the right food makes us avoid many diseases such as blood pressure and diabetes, in addition to helping us to make a diet to reduce weight for those who suffer from obesity.
This project mainly focus on one kind of food which is nasi, and use deep learning (a branch of machine learning) to categorize it. The following is the introduction of nasi and deep Learning.

### *A. The six types of nasi in this paper*

Nasi: Indonesian and Malay word for cooked rice, featured in many Southeast Asian dishes, there are many kinds of it, such as nasi ambeng, nasi bakar, nasi bogana, nasi campur, nasi dagang, nasi goreng jawa and so on.

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In this project, there are six types of nasi which are respectively nasi briyani, nasi dagang, nasi kerabu, nasi lemuni, nasi minyak, nasi tomato.
(a) Nasi Beriani: A mixed rice dish from the Indian subcontinent, made with spices, rice, and meat or vegetables. It is influenced by Islamic cuisine, with common ingredients like ghee, nutmeg, cardamom, and basmati rice.(b) Nasi Dagang: A Malaysian dish with rice steamed in coconut milk, served with fish curry, and often accompanied by pickled cucumber and carrots, typically eaten as breakfast in the East Coast states of Malaysia.(c) Nasi Kerabu: A Malaysian rice dish with blue rice (colored by butterfly pea flowers), served with dried fish or fried chicken, crackers, and pickles.
It can also be made with turmeric rice.(d) Nasi Lemuni: A Malaysian rice dish eaten for confinement, cooked with the herb vitex trifolia, believed to aid digestion and balance hormones. It's similar to nasi lemak but uses daun lemuni.(e) Nasi Minyak: A fragrant rice dish, often served at Malay weddings, made with ghee, evaporated milk, spices, and pandan leaves.(f) Nasi Tomato: A flavorful Malaysian rice dish often served with Ayam Masak Merah (spicy chicken in tomato sauce), popular at weddings.

### *B. Deep learning*

Deep learning (DL), which is used in this project to classify nasi. Deep learning is a new research direction in the field of Machine Learning (ML). It is introduced into Machine Learning to make it closer to its original goal -- Artificial Intelligence (AI). The ultimate goal is for machines to be able to learn analytically, like humans, and to recognize data such as text, images and sound.
Deep learning is a complex machine learning algorithm that has achieved far more results in speech and image recognition than previous related technologies [4].
Deep learning is a general term for a class of pattern analysis methods. In terms of specific research content, it mainly involves three methods: (1) Neural network system based on convolution operation, which name is convolutional neural network (CNN) (2) Self-coding neural network based on multi-layer neurons, including Auto encoder and Sparse Coding, which has received widespread attention in recent years.(3) The deep confidence network (DBN) is used to perform pre-training in the way of multi-layer self-coding neural network, and further optimize the weight of neural network by combining the identification information.
Through multi-layer processing, the initial "low-level" feature representation is gradually transformed into "high-level" feature representation, and the "simple model" can be used to complete complex learning tasks such as classification. Thus, deep learning can be understood as feature learning or representation learning [5].

### *C. Machine learning*

Machine learning is the science of artificial intelligence, and the main research object in this field is artificial intelligence, especially how to improve the performance of specific algorithms in empirical learning.
It is the study of computer algorithms that can be automatically improved through experience.
Machine learning is the use of data or past experience to optimize the performance criteria of computer programs. [6]

## II. LITERATURE SURVEY

### *A. Development history*

*Deep learning*
Deep learning, a subset of machine learning, not only learns associations between features and tasks but also extracts complex features from simpler ones. In 1958, Rosenblatt introduced the Perceptron algorithm, and its convergence was proven in 1962, sparking early neural network research.
However, in 19697, Minsky showed that the Perceptron could only handle linear problems, leading to a 20-year stagnation in the field.
In the 1980s, Hinton's backpropagation algorithm (1986) enabled multi-layer perceptrons to solve non-linear problems using the Sigmoid function, sparking a second wave of neural network research. In 1998, Yann LeCun introduced LeNet-5, a deep convolutional neural network (CNN) that became the foundation for modern CNNs, successfully applied to MNIST digit recognition.
In 2006, Hinton coined the term "deep learning." Advances such as stochastic gradient descent (SGD), dropout, and optimization strategies, along with GPU computing, addressed challenges in training deep networks. This led to a global surge in deep learning research. Over the last decade, significant architectures like AlexNet, Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM) networks, and Generative Adversarial Networks (GANs)8 have further driven deep learning's success.

*B. Current status*

Deep learning has been successfully applied to image classification, speech recognition, and natural language processing. Food image classification, particularly for dishes like nasi (rice), is an emerging field with potential applications in health and nutrition, such as diet monitoring and calorie estimation. While several deep learning models for food classification exist, research in this area is still in its early stages, particularly for specialized types of nasi. The proposed model aims to simplify and improve the classification of nasi types, making it easier for people to identify different varieties.

*C. Related Work*

Machine learning techniques have long been limited in the ability to process natural data in its raw form. but the limitations of deep learning have changed, because of the large availability of data such as images and videos, the use of deep learning, especially neural networks, in processing images, videos, speech and sound to solve many problems such as speech recognition, visual recognition of objects, drug discovery, etc[10]. In the study performed by Mohamad Aqib Haqmi Abas, Nurlaila Ismail, Ahmad Ihsan, Mohd Yassin and Mohd Nasir Taib, vgg16 model was applied to distinguish flower types and the classification accuracy was obtained for training 96%, validation 93% and for the test 89%[11]. In the study performed by David J. Attokaren, Ian G. Fernandes, A. Sriram, Y.V. Srinivasa Murthy, and Shashidhar G. Koolagudi to make a food classification to know the type of food being eaten. In this project, neural networks consisting of 2D convolution layer as well as max pooling were used, Food-101 dataset was used, and 86% accuracy was obtained to classify the food type[12]. Deep learning will change the way we live, learn and relate to each other. There will be little need for human intervention to tackle large tasks to solve faster and more accurately[13]. In this project, classifying the type of food nasi is a step forward to reduce human intervention, and classifying food helps us, for example, in calculating calories to avoid many diseases.

## III. PROPOSED DEEP LEARNING FOR NASI RECOGNITION

*A. The proposed CNN architecture*

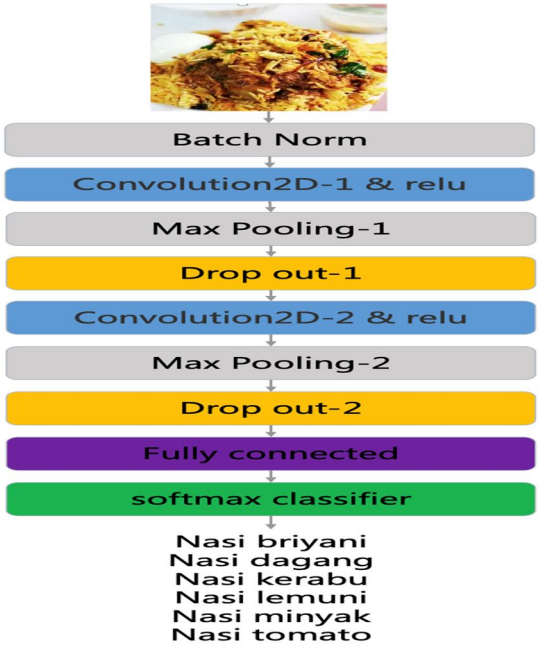


Figure 1. Proposed CNN Architecture

*B. Transfer learning model*

We list three CNN popular CNN architecture

*VGG16*

VGG16 default architecture is used in this paper. We freeze some and change the dense layer, after training and tuning parameter.

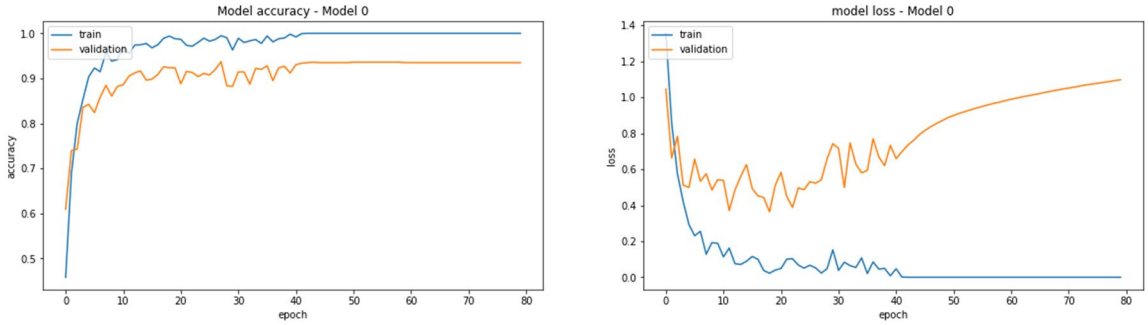


Figure 2. The result of best performing model for Nasi using VGG16

*Xception*

Xception default architecture is used in this paper. We freeze some and change the dense layer, after training and tuning parameter

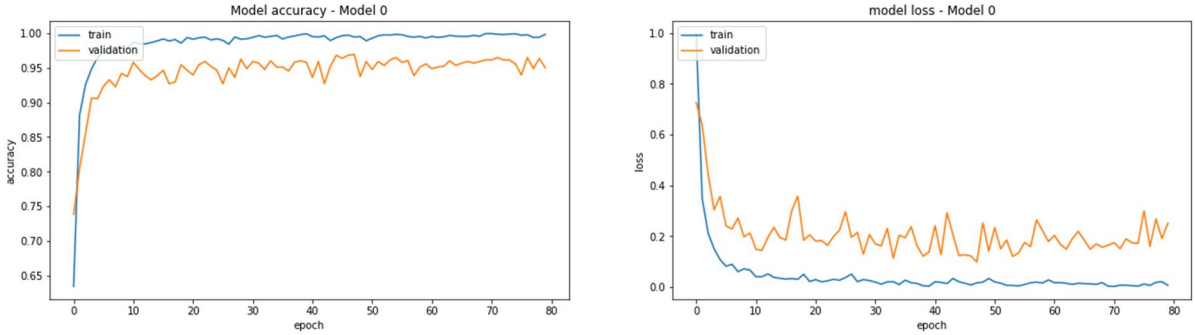


Figure 3. The result of best performing model for Nasi Using Xception

*ResNet*

In this experiment, we use the same design and architecture as the one used in experiment1. The only difference is setting all the ResNet50 layers to be trainable in this experiment. The total number of trainable parameters is around 24 million. We use the exact training configurations as experiment1. The following is the summary of the model.

| Layer (type) | Output Shape | Param # |
|---|---|---|
| sequential_16 (Sequential) | (None, 180, 180, 3) | 0 |
| resnet50 (Functional) | (None, 2048) | 23587712 |
| flatten_8 (Flatten) | (None, 2048) | 0 |
| dense_17 (Dense) | (None, 512) | 1049088 |
| dense_18 (Dense) | (None, 6) | 3078 |

Total params: 24,639,878
Trainable params: 24,586,758
Non-trainable params: 53,120

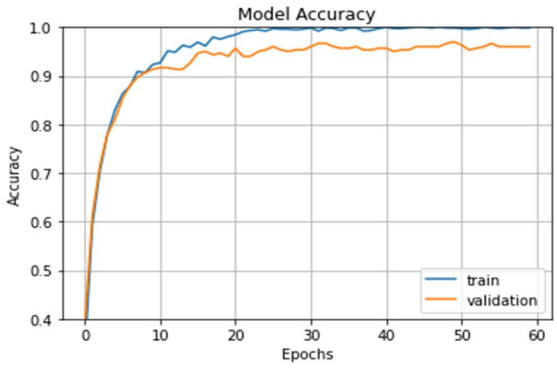


Figure 4. The result of best performing model for Nasi Using ResNet

*C. Augmentation*

There are 6 types of nasi in this study and it contains 1800 images in the data set. We use Keras ImageDataGenerator to do image augmentation, this technique is a great way to expand the size of your dataset. We can come up with 5400 new transformed images from the original dataset. Image rotation is one of the widely used augmentation techniques and allows the model to become invariant to the orientation of the object. horizontal flip for flipping along the horizontal axis. The fill_mode argument and the default value is “nearest” which simply replaces the empty area with the nearest pixel values.

## IV. PERFORMANCE RESULT

### *A. Proposed CNN model parameter*

*Effects of hyper-parameters of the proposed model*

Effect of optimizers: The four optimizers used are Adam, SGD, RMSprop and Adagrad. The Adam optimizer is the best optimizer for our model giving the validation accuracy of 90.97% while SGD given the best test accuracy of 77.53%.

TABLE I. EFFECTS OF OPTIMIZERS

| optimizers | Validation | | Test | |
|---|---|---|---|---|
| | acc | loss | acc | loss |
| Adam | 0.90296805 | 0.36230570 | 0.9479 | 0.2009 |
| sgd | 0.89383560 | 0.37416822 | 0.9260 | 0.2535 |
| RMSprop | 0.88470322 | 0.41570288 | 0.9315 | 0.3168 |
| Adagrad | 0.88470322 | 0.79260713 | 0.7616 | 0.6855 |

Effect of Batch Size: This model is executed with the following batch sizes: 5,10,20,40,80. The model produced the highest accuracy and lowest loss which is shown in Figure below.

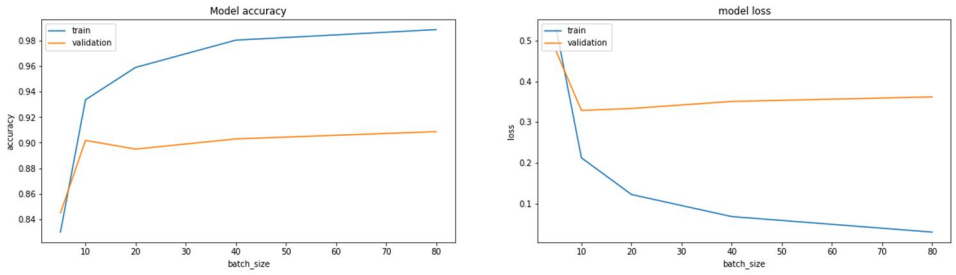


Figure 5. Effects of Batch size

Effect of Number of epochs: Epochs are nothing but the number of iterations. in this experiment, we set epochs range from 1 to 80. From the figure below, we know that epoch 80 gives the largest accuracy and lowest loss.

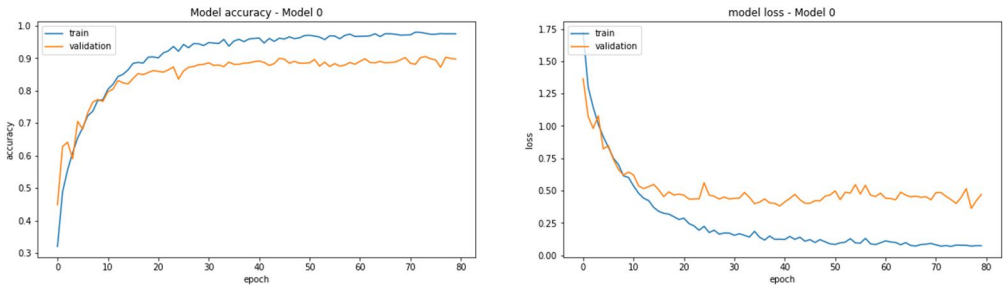


Figure 6. Effects of epochs

Effect of learning rates: The four learning rates are 0.1, 0.01, 0.001,and 0.0001. From Figure below, the best learning rate is 0.001.

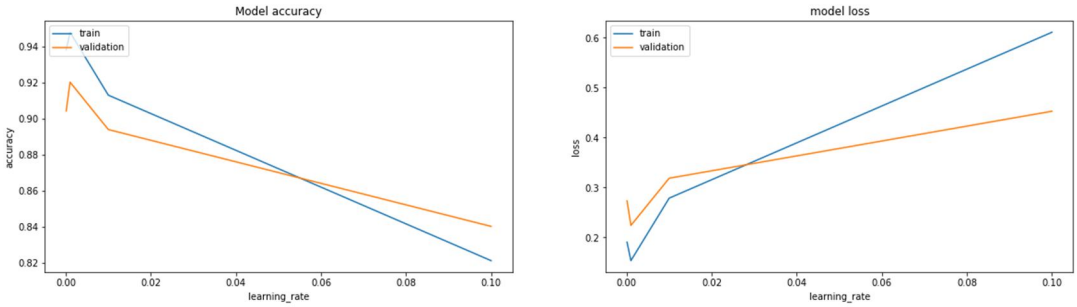


Figure 16. Effects of learning rate

*B. Comparison of classification accuracies of the proposed and transfer learning models*

The table below shows the best combination of hyperparameters that were obtained by hyper-tuning of parameters.

TABLE II. ACCURACY OF PROPOSED AND TRANSFER LEARNING MODEL

| Model | Validation | | Test | |
|---|---|---|---|---|
| | accuracy | loss | accuracy | loss |
| VGG-16 | 0.92351598 | 0.36406791 | 0.9397 | 0.3606 |
| Xception | 0.96917808 | 0.09875302 | 0.9342 | 0.2435 |
| ResNet | 0.9568 | 0.1278 | 0.9616 | 0.0961 |
| Proposed Model | 0.94292235 | 0.21908644 | 0.9288 | 0.2490 |

It obviously that Xception is the best model which has highest validation accuracy 96.9%, However ReNet has highest test accuracy 96.2%.

## V. CONCLUSION

This project is about a sample nasi classification, use 6 types of nasi(nasi briyani, nasi dagang, nasi kerabu,nasi lemuni, nasi minyak, nasi tomato) about 1800 images as database, using Convolutional Neural Network(CNN) and this model can distinguish six types of nasi, there's a lot of model can classify different kinds of food but the model which categorize nasi are hardly any, this model is one of the very few, and it's available for free. The model Xception has the highest validation accuracy 96.9% and ReNet has highest test accuracy 96.2%.

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