成都理工大学中英合作办学
CDUT Sino-British Collaborative Education

OXFORD BROOKES UNIVERSITY

UNDERGRADUATE PROJECT PROGESS REPORT

Project Title:	**Dog Breed Classification using Convolutional Neural Network**
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Module Name:	**Project**
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1. Introduction

1.1. Background

Dogs are the most common animals in people's daily life for many years and dogs had become the friendly partner. Currently, all around us there were so many different kinds of dogs and new breed dogs that we had never seen before. [1] However, there are many different kinds of dogs due to genetic reasons. Now many different breeds of dogs are interbreeding with each other to produce new breeds. Differences between various aspects of the breed have become one of the most important reasons for dog classification. The number of dog breeds certified by the FCI reached 356 in 2022. [2] Only many dog breeds are known by human. However, for the vast majority of dog breeds, humans are not very good at distinguishing which dog breeds are which.

Recently experts have used many different of traditional image classification methods to classify dogs. In 2012, J Liu et al. used the dog breed recognition method based on local localization for classification. [3] Based on the data set established by J Liu et al., X Wang et al. proposed the dog breed recognition method using Grassmann manifold in 2014. [4] However, these methods are very time-consuming and these methods just can be written under certain conditions with high accuracy. In addition, datasets need to be fully labeled, and the cost of preprocessing is high.

1.2. Aim

In this study, I will adopt a transfer learning method. Dog breed classification is achieved by using a pre-trained model. A pre-trained model is a preserved model that has been previously trained on a large dataset. Therefore, a model pre-trained across the entire ImageNet dataset is selected and used to extract the features of the image for input into a customized small-scale output network.

1.3. Objectives

The objectives are as follow:

a. Understand the background of the dog breed classification by using deep learning. Using the transfer learning's pretrained framework to complete the classification.

b. Identify the dataset about dog breed classification. It must include train, valid, test, size of images about ImageNet.

c. The pre-trained model will be used as a fixed image feature extractor.

d. Adding a global averaging pooling layer and fully connected layers for the classification of dog breeds.

1.4. Project Overview

This study is based on convolutional neural network about deep learning, using the pre-training model in transfer learning to classify dog breeds.

1.4.1. Scope

This design has realized the classification of 120 common dog breeds. In view of the problems of high time and cost in literature [3-4], the reason why dog breed identification is commonly used in the actual environment is fully considered. And the accuracy of image recognition. The convolutional neural network is used as the design basis for dog breed recognition.

The significant of this project are as follows:

a. Learning the existing model through application migration greatly reduces the time cost and data resource overhead.

b. Pre-processing and augmentation of dataset will be analyzed for the improvement of the model performance.

c. Using convolutional neural network can improve the accuracy of classification.

With the application of a transfer learning, the pre-trained model with be trained on the pre-processed dataset for an efficient classification of the 120 dog breeds.

1.4.2. Audience

The audience of dog breed classification can follow:

a. Children: Kids don't have very good cognitive skills with dogs. It can help children identify different breeds of dogs.

b. Government: It can provide information about different dog breeds for the government.

c. Dog lovers: Dog breed classification can be more informative for people who love dogs and want to buy them as pets.

d. Doctor: It can provide doctors with knowledge of different dogs to help them understand dogs better.

2. Background Review

2.1. Summary of existing approaches (e.g., Competitive analysis, if appropriate)

This section describes previous current attempts to investigate different approaches of deep learning application for dog breed. Raduly et al. 's [5] study is based on fine-tuning of CNN, the result of which is replicable of the original Stanford dog dataset using the proposed method. Similarly, Liu et al. [6] reported an accuracy of 67% for 133 dog breeds from the Columbia Dogs Dataset by combining SIFT descriptors and color histograms on the SVM classifier with landmark data. Lai et al. [7,8] introduced a deep learning method by transfer learning on convolutional neural networks (CNN) and achieved 86.63% accuracy on the same dataset in [6].

Kumar et al. [9] used principal component analysis (PCA) to analyze 8,351 dog images and achieved 90% accuracy. Jain et al. [10] took convolutional neural network as the basis for predicting dog breeds and cited Res-Net model, making the accuracy rate reach 84.578%. Borwarnginn et al. [11] achieved an accuracy rate of 89.92% for 133 dog breeds by using the pre-trained convolutional neural network. Jiongxin et al. [12] established geometric and appearance models of the dog breeds and their facial parts based on samples, thus completing 133 dog breeds and 8351 images with 67% accuracy. Based on the neural network retraining image classification model, Dabrowski and Michalik [13] adopted the transfer learning method to achieve 70% accuracy. Vrbani et al. [14] used a trained model to classify a set of X-ray images with an overall accuracy of 94.76%.

In summary, it is shown that the application of convolutional neural network has the advantages of automatic feature extraction, strong feature extraction ability and end-to-end training. Thus, applying it to the challenge faced in dog breed identification will improve the cost and technical difficulty in traditional identification methods.

Table 1: Summary of existing methods for dog breed classification

Researchers	Their Model	Performance Metrics
Kumar et al. [9]	ResNet + PCA	Accuracy = 90%

Jain et al. [10]	Res-Net	Accuracy = 84.578%
Borwarnginn et al. [11]	Pretrained	Accuracy = 88.92%
Jiongxin et al. [12]	Not find	Accuracy = 67%
Dbrowski and Michalik [13]	Re-trained	Accuracy = 70%
Vrbani et al. [14]	Pretrained	Accuracy = 94.76%

3. Project Technical Progress

3.1. Methodology

3.1.1. Approach

In the design and implementation, dog breed recognition will be implemented using a a pre-trained model. The pre-trained model is a model created to solve the problems in the past. When you solve a problem, instead of training a new model from scratch, you can start with models that have been trained on similar problems.

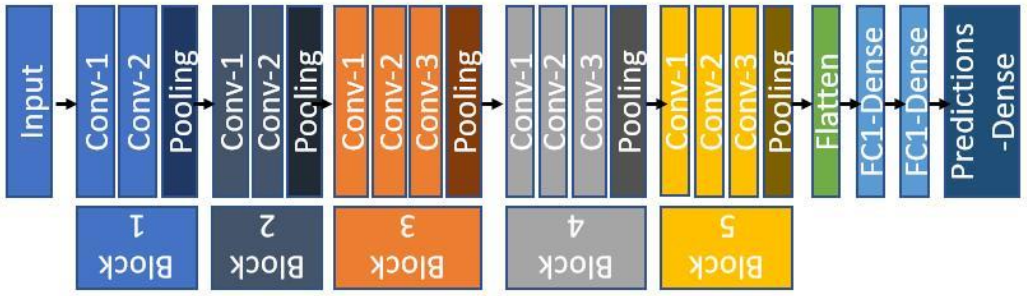


Figure 1: The pre-trained architecture for this project [8].

Dataset:

https://www.kaggle.com/competitions/dog-breed-identification/data

This data set provides a training set and a test set. The data set included 120 dog breeds. Each image has a unique file name.

a. Total number of dataset: 20581

b. The number of train: 10222

c. The number of test: 10357

d. Size of image (length * breadth * channel): 224*224*3

3.1.2. Technology

1. GPU: Intel Core 15 8th Gen

2. Memory: 8GB

3. Disk space: 256GB

Software Requirements:

1. Win 10 64-bits

2. Framework: Tensorflow

3. Language: Python

4. Pre-trained model: Xception, VGG-16, ResNet50

5. Libraries: Numpy, matplotlib, keras

3.2. Testing and Evaluation

There are two parts to testing and evaluation. First, the first part is completed including loss and accuracy graphs for training and testing data on dog breed classification. In addition, we will discuss the evaluation of dog breed recognition. The following evaluation criteria are used as indicators of the diagnostic performance of our model: Accuracy (ACC), precision (PRC), recall, sensitivity (SEN), specificity. The metrics are explained below.

True Positive (TP): indicates that the number of positive classes is predicted to be positive

True Negative (true negative, TN): predicts the number of negative classes as negative

False Positive (FP): Predict the number of negative classes to positive classes (Type I error)

False Negative(false negative, FN) : predicts the number of positive classes as negative classes → misses (Type II error)

	Positive	Negative
True	True Positive (TP)	True Negative (TN)
False	False Positive (FP)	False Negative (FN)

$$\mathrm{ACC} = \frac{\mathrm{TP} + \mathrm{TN}}{\mathrm{TP} + \mathrm{FN} + \mathrm{FP} + \mathrm{TN}}$$

$$\mathrm{Precision} = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FP}}$$

$$\mathrm{Recall} = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FN}}$$

$$\mathrm{Sensitivity} = \frac{\mathrm{TP}}{\mathrm{TP} + \mathrm{FN}}$$

$$\mathrm{Specificity} = \frac{\mathrm{TN}}{\mathrm{TN} + \mathrm{FP}}$$

3.3. Design and Implementation

This section describes in detail all of the progress that has been designed or developed and implemented to date. My project used three different models for evaluation of the data separately. Initially, the VGG-16 model was used. Due to inappropriate data set. As a result, data processing and final training results are not ideal. Next, the data is trained using ResNet50 and Xception models. Among them, ResNet50 has achieved better test results. The rest of the design process and implementation are shown below.

Pretrained model:

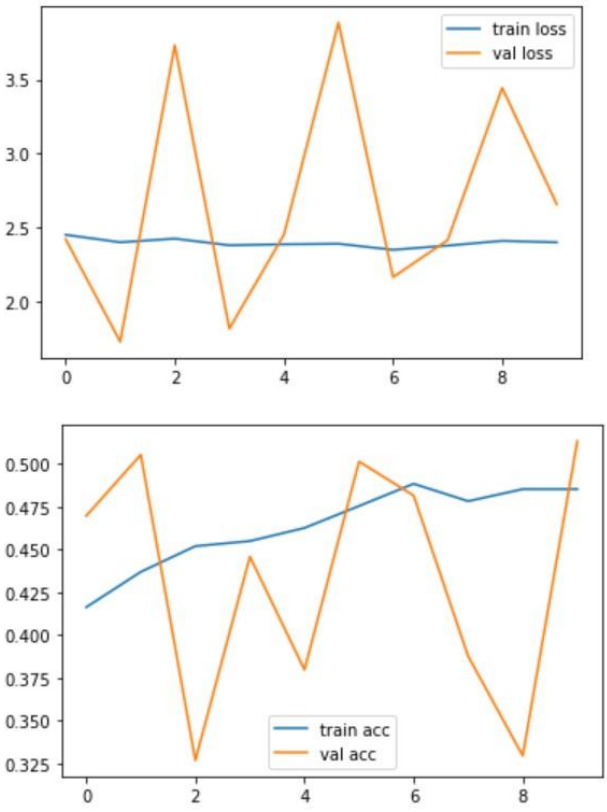
1. VGG-16:

   Epochs: 20

Final training accuracy: 48.5%

Final validation accuracy: 51.3%

The first figure is train loss and validation loss. The next figure is train acc and validation accuracy.



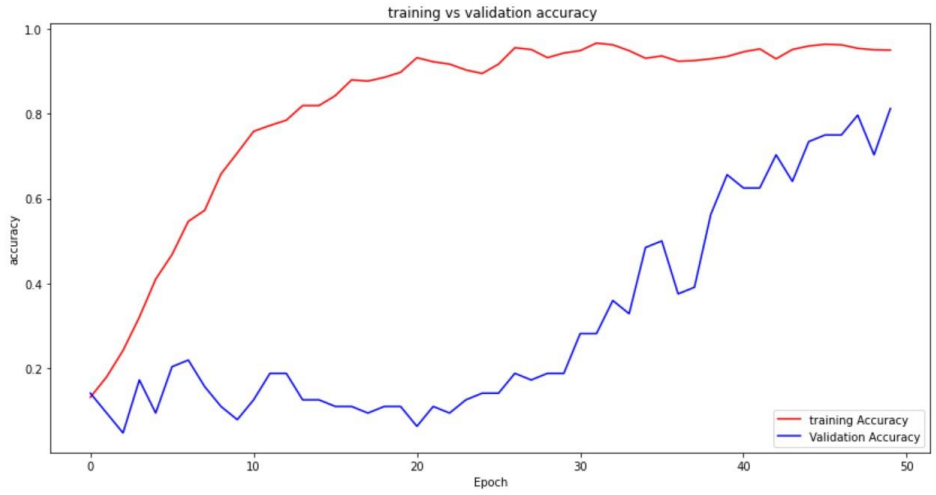
2. ResNet50:

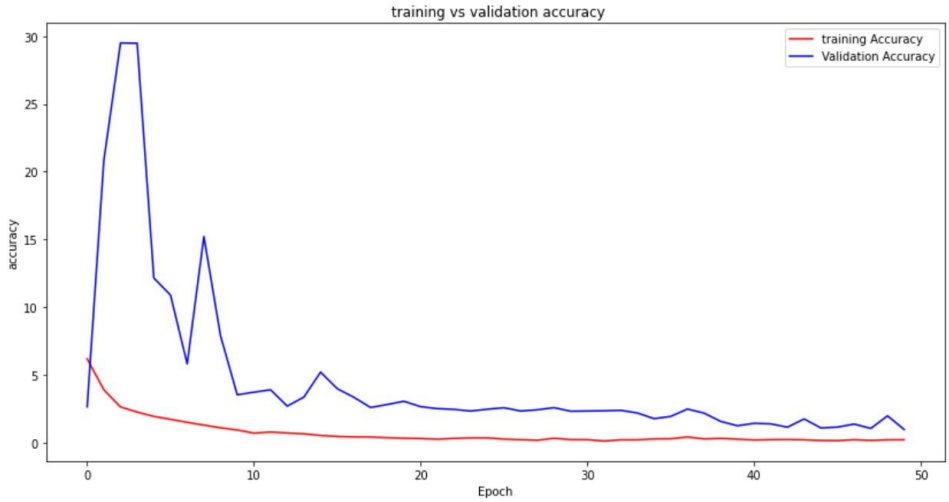
   Epochs: 50

   Final training accuracy: 95%

   Final validation accuracy: 81.2%

The figures are training accuracy and validation accuracy.





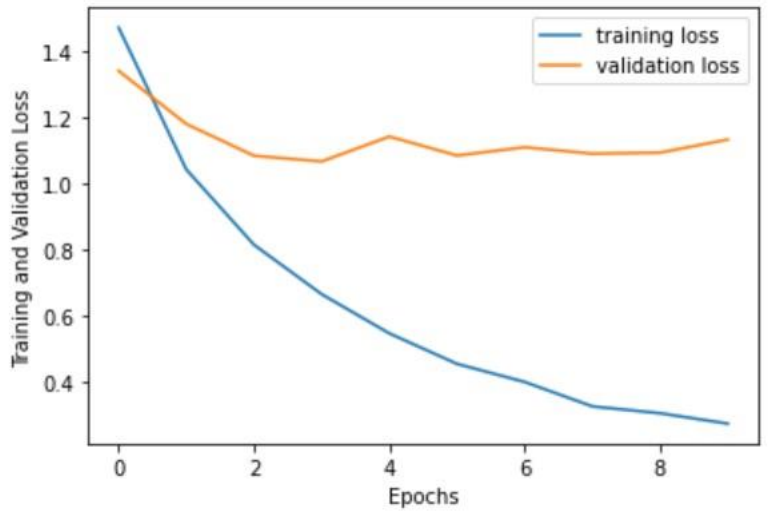
3. Xception:

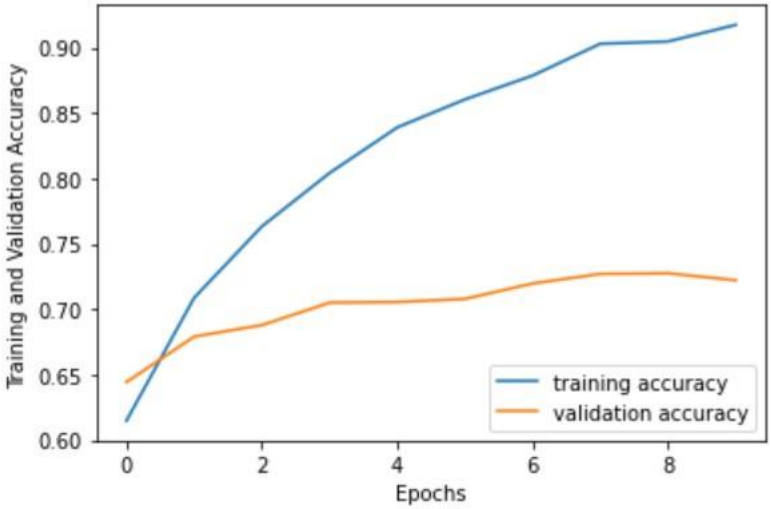
   Epochs:15

   Final training accuracy: 91.7%

   Final validation accuracy: 72%

   The first figure is train loss and validation loss. The next figure is train acc and validation accuracy.





4. Project Management

4.1. Activities

a. Image preprocessing needs to select corresponding data sets for data set organization.

b. The data set is then trained and validated.

c. After the data set is organized, the images stored in the folder are read in. The read image is stored as a tensor of the height * width * channel shape.

d. Select the corresponding model and implement the model in your code.

e. Using transfer learning can speed up and effectively improve efficiency. Then model training is conducted to correct the errors on dataset.

f. Improve the data and modified every codes use different methods about deep learning.

g. Prepare the progress report.

h. Finish the testing code.

i. Write the final report and create poster.

4.2. Schedule

	Task	Start Date	Duration	End Date
1	Learning the basic of Deep Learning and choose the dataset	2022/10/25	7	2022/11/1
2	Understand the CNN model and search the literatures	2022/11/2	5	2022/11/7
3	Prepare Project Proposal and finish it	2022/11/5	6	2022/11/11
4	Learning Deep Learning Framework and prepare software	2022/11/6	8	2022/11/14
5	System Design and prepare	2022/11/10	6	2022/11/16
6	Implementation	2022/11/15	87	2023/2/10
7	Literature Review	2022/10/18	50	2022/12/7
8	Prepare Progress Report	2022/11/19	56	2023/1/13
9	Testing & Evaluation	2023/1/1	78	2023/3/20
0	Write Final Report	2023/1/25	54	**2023/3/20**
1	Create Poster	2023/3/21	13	**2023/4/3**

Figure 3: The schedule

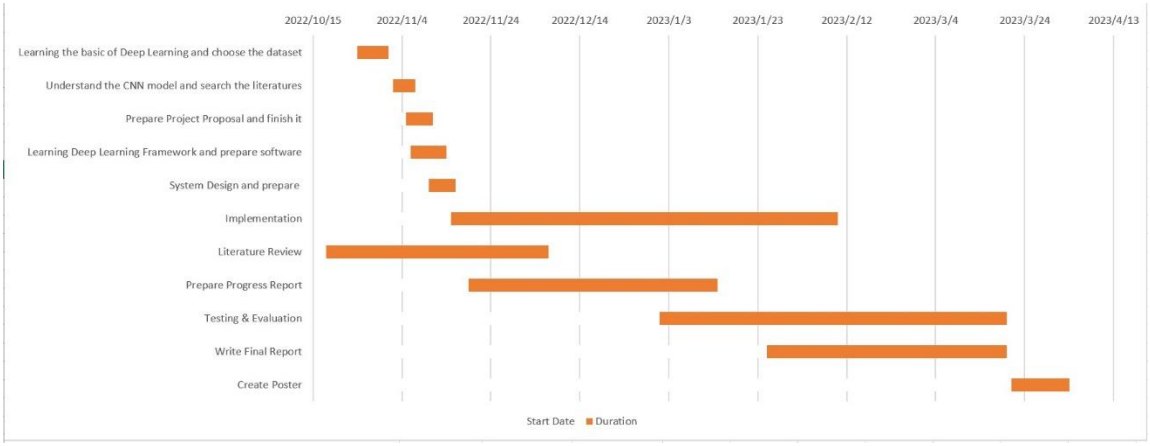


Figure 3: Gantt

4.3. Project Version Management

1. The modified tasks store in a folder every once in a while.
2. Project source codes are logged in a folder of Gitee.

4.4. Project Data Management

a. Store the literatures that need to use in a folder.
b. The minutes of each meeting are stored in a folder.
c. Record each project logs and save it to a folder.
d. Organize every reports into a folder.
e. Store all files on demand into Gitee.

4.5. Project Deliverables

1. Finish the project proposal
2. Finish the progress report
3. Final report.
4. Make source code to the zip file.
5. Create poster.

5. Professional Issues and Risk:

5.1. Risk Analysis

The analysis identifies multiple potential threats to the project, explains why these threats might occur, and finds ways to address these factors. When quantifying risks, factors considered are the probability or likelihood of occurrence and the impact or severity of the risk at the time of occurrence. This information helps to optimize project efficiency and performance.

Potential risks	potential	Severity	Likelihood	Risk	mitigation
Bad program	programming is too complicated.	5	1	5	It can be done through study and practice. In

					addition, use efficient and professional programming techniques to solve,
The final test results is not good	The program is lack of testing.	4	2	8	This can be solved by testing the code more thoroughly.
The model gets terrible accuracy when run it	Data sets cannot be trained well in this model.	2	3	6	Data enhancement is performed on the data set. Resize the dataset and add more data to the dataset.
Date loss	Data is not processed and saved properly.	3	3	9	This can be solved by ensuring that the program backs up data in the event of a sudden loss.
Miss the deadline	Poor GPU system is used in training model	4	3	12	Use a better configuration training model or a different GPU

					system.

5.2 Professional issues

My project does not involve copyright and plagiarism. The project's data set is the ImageNet data set obtained from kaggle.com. It belongs to the development data set. My project borrows from Github open source code. It's public code. It can be used to study dog classification recognition.

6. References

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