

Model Development Phase Template

Date	3 July 2025
Project Title	Dog Breed Identification using Transfer Learning

Initial Model Training Code, Model Validation and Evaluation Report

The initial model training code will be showcased in the future through a screenshot. The model validation and evaluation report will include a summary and training and validation performance metrics for multiple models, presented through respective screenshots.

Initial Model Training Code (5 marks):

```
vgg16.fit(train_generator, validation_data = test_generator, epochs=10 )
```

```
resnet.fit(train_generator, validation_data = test_generator, epochs=10 )
```

```
inception.fit(train_generator, validation_data = test_generator, epochs=10 )
```

```
xception.fit(train_generator, validation_data = test_generator, epochs=10 )
```

Model Validation and Evaluation Report (5 marks):

Model

Summary

Model 1

Model: "model"

Layer (type)	Output Shape	Param #
input_1 (InputLayer)	[(None, 224, 224, 3)]	0
block1_conv1 (Conv2D)	(None, 224, 224, 64)	1792
block1_conv2 (Conv2D)	(None, 224, 224, 64)	36928
block1_pool (MaxPooling2D)	(None, 112, 112, 64)	0
block2_conv1 (Conv2D)	(None, 112, 112, 128)	73856
block2_conv2 (Conv2D)	(None, 112, 112, 128)	147584
block2_pool (MaxPooling2D)	(None, 56, 56, 128)	0
block3_conv1 (Conv2D)	(None, 56, 56, 256)	295168
block3_conv2 (Conv2D)	(None, 56, 56, 256)	590080
block3_conv3 (Conv2D)	(None, 56, 56, 256)	590080
block3_pool (MaxPooling2D)	(None, 28, 28, 256)	0
block4_conv1 (Conv2D)	(None, 28, 28, 512)	1180160
block4_conv2 (Conv2D)	(None, 28, 28, 512)	2359808
block4_conv3 (Conv2D)	(None, 28, 28, 512)	2359808
block4_pool (MaxPooling2D)	(None, 14, 14, 512)	0
block5_conv1 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv2 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv3 (Conv2D)	(None, 14, 14, 512)	2359808
block5_pool (MaxPooling2D)	(None, 7, 7, 512)	0
flatten (Flatten)	(None, 25088)	0
dense (Dense)	(None, 8)	200712

Total params: 14915400 (56.90 MB)
 Trainable params: 200712 (784.83 KB)
 Non-trainable params: 14714688 (56.13 MB)

Training and Validation Performance Metrics

```

gg16.fit(train_generator, validation_data = test_generator, epochs=10 )

Epoch 1/10
1/12 [=====] - 27s 1s/step - loss: 2.2112 - accuracy: 0.2500 - val_loss: 1.4055 - val_accuracy: 0.4286
Epoch 2/10
1/12 [=====] - 9s 74ms/step - loss: 1.2505 - accuracy: 0.5798 - val_loss: 0.9771 - val_accuracy: 0.7143
Epoch 3/10
1/12 [=====] - 8s 67ms/step - loss: 0.8296 - accuracy: 0.7181 - val_loss: 0.9401 - val_accuracy: 0.7143
Epoch 4/10
1/12 [=====] - 10s 83ms/step - loss: 0.6643 - accuracy: 0.7686 - val_loss: 0.6189 - val_accuracy: 0.8571
Epoch 5/10
1/12 [=====] - 10s 84ms/step - loss: 0.5785 - accuracy: 0.8191 - val_loss: 0.5487 - val_accuracy: 0.8571
Epoch 6/10
1/12 [=====] - 9s 71ms/step - loss: 0.4133 - accuracy: 0.8777 - val_loss: 0.2663 - val_accuracy: 0.8571
Epoch 7/10
1/12 [=====] - 10s 80ms/step - loss: 0.4174 - accuracy: 0.9043 - val_loss: 0.2756 - val_accuracy: 1.0000
Epoch 8/10
1/12 [=====] - 10s 83ms/step - loss: 0.3417 - accuracy: 0.8909 - val_loss: 0.2725 - val_accuracy: 0.8571
Epoch 9/10
1/12 [=====] - 8s 68ms/step - loss: 0.3489 - accuracy: 0.9069 - val_loss: 0.3049 - val_accuracy: 1.0000
Epoch 10/10
1/12 [=====] - 9s 68ms/step - loss: 0.2907 - accuracy: 0.9202 - val_loss: 0.1168 - val_accuracy: 1.0000
callbacks:History at 0e7ed584fe080
  
```

Model 2

```
conv5_block2_2_conv (Conv2D) (None, 7, 7, 512) 2150888 ['conv5_block2_2_conv[0][0]']
conv5_block2_2_bn (BatchNormalisation) (None, 7, 7, 512) 2048 ['conv5_block2_2_bn[0][0]']
conv5_block2_2_relu (Activation) (None, 7, 7, 512) 0 ['conv5_block2_2_relu[0][0]']
conv5_block3_1_conv (Conv2D) (None, 7, 7, 2048) 1050624 ['conv5_block3_1_conv[0][0]']
conv5_block3_1_bn (BatchNormalisation) (None, 7, 7, 2048) 8192 ['conv5_block3_1_bn[0][0]']
conv5_block3_1_add (Add) (None, 7, 7, 2048) 0 ['conv5_block3_1_add[0][0]']
conv5_block3_1_out (Activation) (None, 7, 7, 2048) 0 ['conv5_block3_1_out[0][0]']
conv5_block3_1_conv (Conv2D) (None, 7, 7, 512) 1049088 ['conv5_block3_1_conv[0][0]']
conv5_block3_1_bn (BatchNormalisation) (None, 7, 7, 512) 2048 ['conv5_block3_1_bn[0][0]']
conv5_block3_1_relu (Activation) (None, 7, 7, 512) 0 ['conv5_block3_1_relu[0][0]']
conv5_block3_2_conv (Conv2D) (None, 7, 7, 512) 2048 ['conv5_block3_2_conv[0][0]']
conv5_block3_2_bn (BatchNormalisation) (None, 7, 7, 512) 0 ['conv5_block3_2_bn[0][0]']
conv5_block3_2_relu (Activation) (None, 7, 7, 512) 0 ['conv5_block3_2_relu[0][0]']
conv5_block3_3_conv (Conv2D) (None, 7, 7, 2048) 1050624 ['conv5_block3_3_conv[0][0]']
conv5_block3_3_bn (BatchNormalisation) (None, 7, 7, 2048) 8192 ['conv5_block3_3_bn[0][0]']
conv5_block3_3_add (Add) (None, 7, 7, 2048) 0 ['conv5_block3_3_add[0][0]']
conv5_block3_3_out (Activation) (None, 7, 7, 2048) 0 ['conv5_block3_3_out[0][0]']
flatten_1 (Flatten) (None, 148352) 0 ['conv5_block3_3_out[0][0]']
dense_1 (Dense) (None, 8) 803824 ['flatten_1[0][0]']

Total params: 24509536 (93.84 MB)
Trainable params: 802824 (3.06 MB)
```

```
model.fit(train_generator, validation_data = test_generator, epochs=10)

Epoch 1/10
12/12 [=====] - 17s 941ms/step - loss: 8.6675 - accuracy: 0.1436 - val_loss: 6.4575 - val_accuracy: 0.1429
Epoch 2/10
12/12 [=====] - 8s 647ms/step - loss: 6.9999 - accuracy: 0.1356 - val_loss: 3.4116 - val_accuracy: 0.4286
Epoch 3/10
12/12 [=====] - 8s 636ms/step - loss: 4.2426 - accuracy: 0.1862 - val_loss: 2.2663 - val_accuracy: 0.1429
Epoch 4/10
12/12 [=====] - 9s 778ms/step - loss: 2.8612 - accuracy: 0.2207 - val_loss: 2.5258 - val_accuracy: 0.2857
Epoch 5/10
12/12 [=====] - 9s 750ms/step - loss: 2.5177 - accuracy: 0.2340 - val_loss: 1.5863 - val_accuracy: 0.2857
Epoch 6/10
12/12 [=====] - 8s 652ms/step - loss: 2.2711 - accuracy: 0.2840 - val_loss: 1.5338 - val_accuracy: 0.5714
Epoch 7/10
12/12 [=====] - 9s 774ms/step - loss: 2.2721 - accuracy: 0.2380 - val_loss: 1.4668 - val_accuracy: 0.4286
Epoch 8/10
12/12 [=====] - 9s 776ms/step - loss: 2.0657 - accuracy: 0.2606 - val_loss: 1.5892 - val_accuracy: 0.4286
Epoch 9/10
12/12 [=====] - 8s 646ms/step - loss: 1.9884 - accuracy: 0.2926 - val_loss: 1.5387 - val_accuracy: 0.4286
Epoch 10/10
12/12 [=====] - 9s 766ms/step - loss: 2.7414 - accuracy: 0.1835 - val_loss: 2.1361 - val_accuracy: 0.4286
Chorus src call backs history at 0x7cd504b0800
```

Model 3

```
inception_summary()
batch_normalization_87 (BatchNormalisation) (None, 8, 8, 384) 1152 ['conv2d_87[0][0]']
batch_normalization_88 (BatchNormalisation) (None, 8, 8, 384) 1152 ['conv2d_88[0][0]']
batch_normalization_91 (BatchNormalisation) (None, 8, 8, 384) 1152 ['conv2d_91[0][0]']
batch_normalization_92 (BatchNormalisation) (None, 8, 8, 384) 1152 ['conv2d_92[0][0]']
conv2d_93 (Conv2D) (None, 8, 8, 192) 393216 ['average_pooling2d_8[0][0]']
batch_normalization_85 (BatchNormalisation) (None, 8, 8, 320) 960 ['conv2d_85[0][0]']
activation_87 (Activation) (None, 8, 8, 384) 0 ['batch_normalization_87[0][0]']
activation_88 (Activation) (None, 8, 8, 384) 0 ['batch_normalization_88[0][0]']
activation_91 (Activation) (None, 8, 8, 384) 0 ['batch_normalization_91[0][0]']
activation_92 (Activation) (None, 8, 8, 384) 0 ['batch_normalization_92[0][0]']
batch_normalization_93 (BatchNormalisation) (None, 8, 8, 192) 576 ['conv2d_93[0][0]']
activation_85 (Activation) (None, 8, 8, 320) 0 ['batch_normalization_85[0][0]']
mixed9_1 (Concatenate) (None, 8, 8, 768) 0 ['activation_87[0][0]', 'activation_88[0][0]']
concatenate_1 (Concatenate) (None, 8, 8, 768) 0 ['activation_91[0][0]', 'activation_92[0][0]']
activation_93 (Activation) (None, 8, 8, 192) 0 ['batch_normalization_93[0][0]']
mixed10 (Concatenate) (None, 8, 8, 2048) 0 ['activation_85[0][0]', 'mixed9_1[0][0]', 'concatenate_1[0][0]', 'activation_93[0][0]']
flatten_2 (Flatten) (None, 131072) 0 ['mixed10[0][0]']
dense_2 (Dense) (None, 8) 1048544 ['flatten_2[0][0]']

Total params: 22851368 (87.17 MB)
Trainable params: 22818936 (87.04 MB)
Non-trainable params: 36432 (134.50 KB)
```

```
inception.fit(train_generator, validation_data = test_generator, epochs=10)

Epoch 1/10
12/12 [=====] - 74s 2s/step - loss: 18.1741 - accuracy: 0.2128 - val_loss: 18236.6914 - val_accuracy: 0.1429
Epoch 2/10
12/12 [=====] - 14s 1s/step - loss: 8.7789 - accuracy: 0.1941 - val_loss: 11863.7734 - val_accuracy: 0.1429
Epoch 3/10
12/12 [=====] - 14s 1s/step - loss: 5.5277 - accuracy: 0.2181 - val_loss: 74852.1258 - val_accuracy: 0.1429
Epoch 4/10
12/12 [=====] - 14s 1s/step - loss: 3.1899 - accuracy: 0.1889 - val_loss: 136493.8584 - val_accuracy: 0.1429
Epoch 5/10
12/12 [=====] - 14s 1s/step - loss: 2.9712 - accuracy: 0.1755 - val_loss: 253623.9862 - val_accuracy: 0.2857
Epoch 6/10
12/12 [=====] - 14s 1s/step - loss: 2.9888 - accuracy: 0.1622 - val_loss: 17886.1543 - val_accuracy: 0.1429
Epoch 7/10
12/12 [=====] - 14s 1s/step - loss: 2.8311 - accuracy: 0.1489 - val_loss: 836.5386 - val_accuracy: 0.80000000
Epoch 8/10
12/12 [=====] - 14s 1s/step - loss: 2.4020 - accuracy: 0.1941 - val_loss: 18529.5038 - val_accuracy: 0.1429
Epoch 9/10
12/12 [=====] - 14s 1s/step - loss: 2.2347 - accuracy: 0.1888 - val_loss: 31282.3652 - val_accuracy: 0.1429
Epoch 10/10
12/12 [=====] - 14s 1s/step - loss: 2.3490 - accuracy: 0.2207 - val_loss: 69.5367 - val_accuracy: 0.2857
Chorus src call backs history at 0x7cd504b0800
```

Model 4

```

block11_sepconv1_act (Act1 (None, 19, 19, 728)
viation) 0 ['add_16[0][0]']
block11_sepconv1 (Separabl (None, 19, 19, 728)
econv2D) 536536 ['block11_sepconv1_act[0][0]']
block11_sepconv1_bn (Batch (None, 19, 19, 728)
Normalization) 2912 ['block11_sepconv1[0][0]']
block11_sepconv2_act (Act1 (None, 19, 19, 728)
viation) 0 ['block11_sepconv1_bn[0][0]']
block11_sepconv2 (Separabl (None, 19, 19, 1824)
econv2D) 712824 ['block11_sepconv2_act[0][0]']
block11_sepconv2_bn (Batch (None, 19, 19, 1824)
Normalization) 4896 ['block11_sepconv2[0][0]']
conv2d_97 (Conv2D) (None, 18, 18, 1824) 745472 ['add_18[0][0]']
block11_pool (MaxPooling2D (None, 18, 18, 1824)
) 0 ['block11_sepconv2_bn[0][0]']
batch_normalization_57 (Ba (None, 18, 18, 1824)
tchNormalization) 4896 ['conv2d_97[0][0]']
add_11 (Add) (None, 18, 18, 1824) 0 ['block11_pool[0][0]',
'batch_normalization_57[0][0]']

block14_sepconv1 (Separabl (None, 18, 18, 1536)
econv2D) 1182088 ['add_11[0][0]']
block14_sepconv1_bn (Batch (None, 18, 18, 1536)
Normalization) 6144 ['block14_sepconv1[0][0]']
block14_sepconv1_act (Act1 (None, 18, 18, 1536)
viation) 0 ['block14_sepconv1_bn[0][0]']
block14_sepconv2 (Separabl (None, 18, 18, 2048)
econv2D) 3159552 ['block14_sepconv1_act[0][0]']
block14_sepconv2_bn (Batch (None, 18, 18, 2048)
Normalization) 8192 ['block14_sepconv2[0][0]']
block14_sepconv2_act (Act1 (None, 18, 18, 2048)
viation) 0 ['block14_sepconv2_bn[0][0]']
flatten_3 (Flatten) (None, 204800) 0 ['block14_sepconv2_act[0][0]']
dense_3 (Dense) (None, 8) 1638400 ['flatten_3[0][0]']

Total params: 22495808 (85.83 MB)
Trainable params: 1638400 (6.25 MB)
Non-trainable params: 20857408 (79.58 MB)

```

```

epoch.fit(train_generator, validation_data = test_generator, epochs=10 )

Epoch 1/10
1/12 [=====] - 29s 2s/epoch - loss: 1.8818 - accuracy: 0.9411 - val_loss: 0.8888e+00 - val_accuracy: 1.0000
Epoch 2/10
1/12 [=====] - 13s 1s/epoch - loss: 0.2874 - accuracy: 0.9814 - val_loss: 0.4364 - val_accuracy: 1.0000
Epoch 3/10
1/12 [=====] - 13s 1s/epoch - loss: 0.1984 - accuracy: 0.9814 - val_loss: 2.8977 - val_accuracy: 0.8571
Epoch 4/10
1/12 [=====] - 12s 1s/epoch - loss: 0.2354 - accuracy: 0.9814 - val_loss: 0.8888e+00 - val_accuracy: 1.0000
Epoch 5/10
1/12 [=====] - 13s 1s/epoch - loss: 0.1156 - accuracy: 0.9947 - val_loss: 0.8888e+00 - val_accuracy: 1.0000
Epoch 6/10
1/12 [=====] - 13s 1s/epoch - loss: 0.8178 - accuracy: 0.9947 - val_loss: 0.8888e+00 - val_accuracy: 1.0000
Epoch 7/10
1/12 [=====] - 12s 1s/epoch - loss: 0.8562 - accuracy: 0.9928 - val_loss: 0.8888e+00 - val_accuracy: 1.0000
Epoch 8/10
1/12 [=====] - 13s 1s/epoch - loss: 0.8845 - accuracy: 0.9973 - val_loss: 8.5149e-08 - val_accuracy: 1.0000
Epoch 9/10
1/12 [=====] - 13s 1s/epoch - loss: 0.8892 - accuracy: 0.9973 - val_loss: 1.7830e-08 - val_accuracy: 1.0000
Epoch 10/10
1/12 [=====] - 12s 1s/epoch - loss: 0.8814 - accuracy: 1.0000 - val_loss: 3.4808e-08 - val_accuracy: 1.0000
Epoch 10: val_loss: 3.4808e-08

```