IMPLEMENTATION OF OUR OWN AI ALGORITHM

Erfasser :

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In this work, we are implementing 4 AI Methods:

- Decision Tree
- Random Forest
- K - Nearest Neighbor
- Convolutional Neural Networks

Loading Data from Image Resources

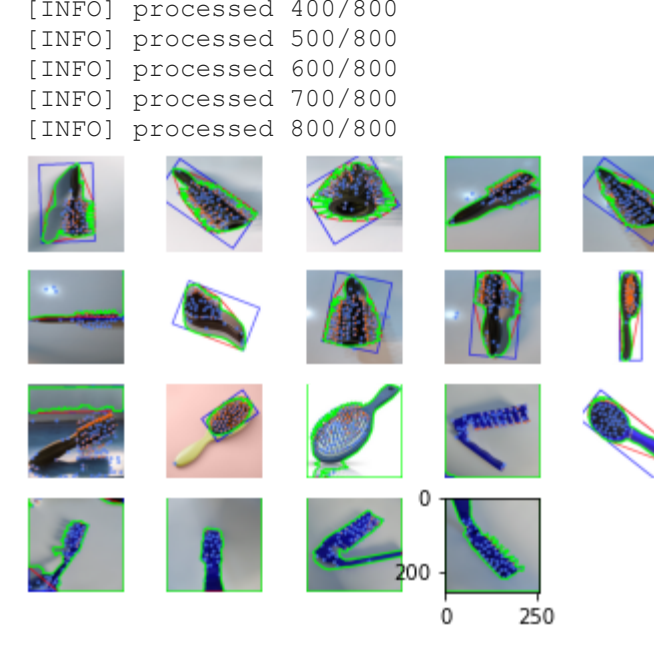
In [1]:
```
# listing all images inside the resources!
from our_own_ai_process import OurDecisionTree, OurRandomForrest, OurKNearestNeighbour, OurCNN
from preprocessing import ImageResizer, FeatureExtraction, SimpleDatasetLoader
from imutils import paths
from preprocessing.image_to_array import ImageToArrayPreprocessor
```

In [2]:
```
# listing all images inside the resources!
imagePaths = list(paths.list_images("resources/"))
# initialize the image resizer, load the dataset from disk, and reshape the data matrix
sp = ImageResizer(256, 256)
# another image resizer for data in cnn
sp2 = ImageResizer(32, 32)
# initialize the feature extractor that will save it to csv file
f_ext = FeatureExtraction()
# initialize the converter to array using keras, will be use in cnn
iap = ImageToArrayPreprocessor()

# initialize data set loader that will load the images and do the preprocessing before it
sdl = SimpleDatasetLoader(preprocessors=[sp, f_ext, sp2, iap])
```

In [3]:
```
print("[INFO] loading images...")
# load the images
(data, label) = sdl.load(imagePaths, verbose=100, show=20)
```

```
[INFO] loading images...
[INFO] processed 100/800
[INFO] processed 200/800
[INFO] processed 300/800
[INFO] processed 400/800
[INFO] processed 500/800
[INFO] processed 600/800
[INFO] processed 700/800
[INFO] processed 800/800
```



In [4]:
```
# extraction direct to panda data frame
df = f_ext.extract_to_panda(label)
df.sample(10)
# extract to the csv file
# uncomment to extract to a csv file
# f_ext.extract_to_table("features.csv", labels)
```

Out[4]:

	n_corner	n_h_corner	n_contour	a_rect	a_hull	a_approx	l_perimeters	wide/length	perim/a_rect	perim/a_hull	...	corner/a_hull
671	92	1059	14	65025.000000	65025.0	57556.5	1568.482317	1.000000	0.024121	0.024121	...	0.001415
146	100	585	13	65025.000000	64818.5	38606.0	1814.749343	1.000000	0.027908	0.027997	...	0.001543
14	60	440	14	65025.000000	64292.0	64132.5	1015.899495	1.000000	0.015623	0.015801	...	0.000933
211	50	264	2	18297.949064	14442.0	12087.5	682.991983	4.482075	0.037326	0.047292	...	0.003462
594	37	112	3	65025.000000	65025.0	65017.0	1025.656854	1.000000	0.015773	0.015773	...	0.000569
507	51	218	4	65025.000000	65025.0	48214.5	1658.859953	1.000000	0.025511	0.025511	...	0.000784
741	42	275	5	9417.000000	8131.5	6380.5	597.480229	5.093023	0.063447	0.073477	...	0.005165
785	36	417	2	8968.821070	8267.0	7818.5	546.249781	0.169359	0.060905	0.066076	...	0.004355
490	37	292	2	12567.118770	11616.5	11311.5	641.050858	5.300913	0.051010	0.055185	...	0.003185
635	51	434	2	65025.000000	65025.0	55027.0	1731.536140	1.000000	0.026629	0.026629	...	0.000784

10 rows × 22 columns

Decision Tree

In [5]:
```
# Decision Tree with max depth 10
ODT = OurDecisionTree(depth=10)
ODT.fit(df, 0.1)
ODT.train()
# ODT.plot_tree()
```

In [6]:
```
ODT.predict()
(a, b, c) = ODT.review()
print("Decision Tree Report")
print("Accuracy", a)
print(b)
print("Confusion Matrix:\n", c)
```

```
Decision Tree Report
Accuracy 0.7375
              precision    recall  f1-score   support

       brush       0.80      0.72      0.76        46
        comb       0.67      0.76      0.71        34

    accuracy                           0.74        80
   macro avg       0.74      0.74      0.74        80
weighted avg       0.75      0.74      0.74        80

Confusion Matrix:
 [[33 13]
 [ 8 26]]
```

Random Forest

In [7]:
```
# Random Forest with 5 trees and depth 10
ORF = OurRandomForest(n_trees=5, depth=10)
ORF.fit(df, 0.1)
ORF.train()
ORF.predict()
(a, b, c) = ORF.review()
print("Random Forest Report")
print("Accuracy", a)
print(b)
print("Confusion Matrix:\n", c)
```

```
Random Forest Report
Accuracy 0.7625
              precision    recall  f1-score   support

       brush       0.78      0.76      0.77        41
        comb       0.75      0.77      0.76        39

    accuracy                           0.76        80
   macro avg       0.76      0.76      0.76        80
weighted avg       0.76      0.76      0.76        80

Confusion Matrix:
 [[31 10]
 [ 9 30]]
```

K-Nearest Neighbor

In [8]:
```
# K-NN with 5 N and euclidean distance calculation
fiveNearestNeighbour = OurKNearestNeighbour(5, "euclidean")
fiveNearestNeighbour.fit(df, 0.10)
fiveNearestNeighbour.predict()
(a, b, c) = fiveNearestNeighbour.review()
print("KNN Report")
print("Accuracy", a)
print(b)
print("Confusion Matrix:\n", c)
```

```
KNN Report
Accuracy 0.8875
              precision    recall  f1-score   support

       brush       0.80      0.97      0.88        34
        comb       0.97      0.83      0.89        46

    accuracy                           0.89        80
   macro avg       0.89      0.90      0.89        80
weighted avg       0.90      0.89      0.89        80

Confusion Matrix:
 [[33  1]
 [ 8 38]]
```

Convolutional Neural Networks

In [9]:
```
# Epoch 500
# Batch 100
# Learning Rate 0.01
# Shape - Input Image (32,32,3)
cnn = OurCNN(32, 32, 3, learning_rate=0.01, batch_size=100, epochs=400)
cnn.fit((data, label), 0.10)
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 32, 32, 32)        896
_________________________________________________________________
activation (Activation)      (None, 32, 32, 32)        0
_________________________________________________________________
flatten (Flatten)            (None, 32768)             0
_________________________________________________________________
dense (Dense)                (None, 2)                 65538
_________________________________________________________________
activation_1 (Activation)    (None, 2)                 0
=================================================================
Total params: 66,434
Trainable params: 66,434
Non-trainable params: 0
_________________________________________________________________
None
```

In [10]:
```
cnn.train()
```

```
Epoch 1/400
8/8 [==============================] - 1s 80ms/step - loss: 0.7009 - accuracy: 0.4958 - val_loss: 0.6999 - val_
accuracy: 0.487
5
Epoch 2/400
8/8 [==============================] - 0s 67ms/step - loss: 0.7001 - accuracy: 0.4819 - val_loss: 0.6976 - val_
accuracy: 0.487
5
Epoch 3/400
8/8 [==============================] - 0s 64ms/step - loss: 0.6881 - accuracy: 0.5389 - val_loss: 0.6896 - val_
accuracy: 0.525
0
Epoch 4/400
8/8 [==============================] - 0s 66ms/step - loss: 0.6905 - accuracy: 0.5236 - val_loss: 0.6948 - val_
accuracy: 0.512
5
Epoch 5/400
8/8 [==============================] - 0s 54ms/step - loss: 0.6855 - accuracy: 0.5417 - val_loss: 0.6803 - val_
accuracy: 0.525
0
Epoch 6/400
8/8 [==============================] - 0s 51ms/step - loss: 0.6773 - accuracy: 0.5861 - val_loss: 0.7271 - val_
accuracy: 0.487
5
Epoch 7/400
8/8 [==============================] - 0s 57ms/step - loss: 0.6827 - accuracy: 0.5486 - val_loss: 0.7155 - val_
accuracy: 0.512
5
Epoch 8/400
8/8 [==============================] - 0s 49ms/step - loss: 0.6770 - accuracy: 0.5778 - val_loss: 0.6803 - val_
accuracy: 0.537
5
Epoch 9/400
8/8 [==============================] - 0s 62ms/step - loss: 0.6696 - accuracy: 0.6250 - val_loss: 0.7176 - val_
accuracy: 0.487
5
Epoch 10/400
8/8 [==============================] - 0s 45ms/step - loss: 0.6714 - accuracy: 0.5667 - val_loss: 0.6726 - val_
accuracy: 0.550
0
Epoch 11/400
8/8 [==============================] - 0s 46ms/step - loss: 0.6730 - accuracy: 0.5597 - val_loss: 0.6987 - val_
accuracy: 0.525
0
Epoch 12/400
8/8 [==============================] - 0s 52ms/step - loss: 0.6691 - accuracy: 0.5708 - val_loss: 0.6641 - val_
accuracy: 0.612
5
Epoch 13/400
8/8 [==============================] - 0s 47ms/step - loss: 0.6613 - accuracy: 0.5972 - val_loss: 0.6716 - val_
accuracy: 0.550
0
Epoch 14/400
8/8 [==============================] - 0s 49ms/step - loss: 0.6721 - accuracy: 0.5528 - val_loss: 0.6912 - val_
accuracy: 0.550
0
Epoch 15/400
8/8 [==============================] - 0s 45ms/step - loss: 0.6592 - accuracy: 0.6056 - val_loss: 0.7123 - val_
accuracy: 0.512
5
Epoch 16/400
8/8 [==============================] - 0s 53ms/step - loss: 0.6600 - accuracy: 0.6069 - val_loss: 0.6788 - val_
accuracy: 0.550
0
Epoch 17/400
8/8 [==============================] - 0s 49ms/step - loss: 0.6579 - accuracy: 0.6083 - val_loss: 0.7290 - val_
accuracy: 0.487
5
Epoch 18/400
8/8 [==============================] - 0s 51ms/step - loss: 0.6557 - accuracy: 0.6389 - val_loss: 0.6629 - val_
accuracy: 0.550
0
Epoch 19/400
8/8 [==============================] - 0s 47ms/step - loss: 0.6554 - accuracy: 0.6222 - val_loss: 0.7566 - val_
accuracy: 0.512
5
Epoch 20/400
8/8 [==============================] - 0s 68ms/step - loss: 0.6697 - accuracy: 0.5861 - val_loss: 0.6521 - val_
accuracy: 0.625
0
Epoch 21/400
8/8 [==============================] - 0s 50ms/step - loss: 0.6450 - accuracy: 0.6389 - val_loss: 0.6594 - val_
accuracy: 0.550
0
Epoch 22/400
8/8 [==============================] - 0s 52ms/step - loss: 0.6409 - accuracy: 0.6306 - val_loss: 0.6564 - val_
accuracy: 0.587
5
Epoch 23/400
8/8 [==============================] - 0s 50ms/step - loss: 0.6432 - accuracy: 0.6389 - val_loss: 0.6511 - val_
accuracy: 0.600
0
Epoch 24/400
8/8 [==============================] - 0s 52ms/step - loss: 0.6474 - accuracy: 0.6153 - val_loss: 0.8105 - val_
accuracy: 0.487
5
Epoch 25/400
8/8 [==============================] - 0s 50ms/step - loss: 0.6775 - accuracy: 0.5667 - val_loss: 0.6552 - val_
accuracy: 0.587
5
Epoch 26/400
8/8 [==============================] - 0s 55ms/step - loss: 0.6409 - accuracy: 0.6236 - val_loss: 0.6465 - val_
accuracy: 0.637
5
Epoch 27/400
8/8 [==============================] - 0s 51ms/step - loss: 0.6382 - accuracy: 0.6250 - val_loss: 0.6434 - val_
accuracy: 0.637
5
Epoch 28/400
8/8 [==============================] - 0s 57ms/step - loss: 0.6374 - accuracy: 0.6319 - val_loss: 0.6637 - val_
accuracy: 0.575
0
Epoch 29/400
8/8 [==============================] - 0s 51ms/step - loss: 0.6314 - accuracy: 0.6611 - val_loss: 0.7838 - val_
accuracy: 0.512
5
Epoch 30/400
8/8 [==============================] - 0s 49ms/step - loss: 0.6521 - accuracy: 0.6264 - val_loss: 0.7667 - val_
accuracy: 0.500
0
Epoch 31/400
8/8 [==============================] - 0s 50ms/step - loss: 0.6378 - accuracy: 0.6431 - val_loss: 0.6507 - val_
accuracy: 0.600
0
Epoch 32/400
8/8 [==============================] - 0s 55ms/step - loss: 0.6276 - accuracy: 0.6667 - val_loss: 0.6383 - val_
accuracy: 0.637
5
Epoch 33/400
8/8 [==============================] - 0s 54ms/step - loss: 0.6236 - accuracy: 0.6458 - val_loss: 0.6570 - val_
accuracy: 0.612
5
Epoch 34/400
8/8 [==============================] - 1s 65ms/step - loss: 0.6234 - accuracy: 0.6681 - val_loss: 0.6519 - val_
accuracy: 0.587
5
Epoch 35/400
8/8 [==============================] - 0s 59ms/step - loss: 0.6321 - accuracy: 0.6292 - val_loss: 0.6536 - val_
accuracy: 0.587
5
Epoch 36/400
8/8 [==============================] - 0s 52ms/step - loss: 0.6210 - accuracy: 0.6569 - val_loss: 0.6836 - val_
accuracy: 0.550
0
Epoch 37/400
8/8 [==============================] - 0s 53ms/step - loss: 0.6336 - accuracy: 0.6319 - val_loss: 0.6743 - val_
accuracy: 0.562
5
Epoch 38/400
8/8 [==============================] - 0s 52ms/step - loss: 0.6201 - accuracy: 0.6417 - val_loss: 0.6344 - val_
accuracy: 0.612
5
Epoch 39/400
8/8 [==============================] - 0s 48ms/step - loss: 0.6179 - accuracy: 0.6778 - val_loss: 0.6790 - val_
accuracy: 0.550
0
Epoch 40/400
8/8 [==============================] - 0s 53ms/step - loss: 0.6539 - accuracy: 0.6000 - val_loss: 0.6562 - val_
accuracy: 0.587
5
Epoch 41/400
8/8 [==============================] - 0s 54ms/step - loss: 0.6200 - accuracy: 0.6278 - val_loss: 0.6332 - val_
accuracy: 0.662
5
Epoch 42/400
8/8 [==============================] - 0s 64ms/step - loss: 0.6110 - accuracy: 0.6778 - val_loss: 0.6370 - val_
accuracy: 0.637
5
Epoch 43/400
8/8 [==============================] - 0s 54ms/step - loss: 0.6215 - accuracy: 0.6653 - val_loss: 0.6937 - val_
accuracy: 0.562
5
Epoch 44/400
8/8 [==============================] - 0s 62ms/step - loss: 0.6272 - accuracy: 0.6319 - val_loss: 0.6303 - val_
accuracy: 0.662
5
Epoch 45/400
8/8 [==============================] - 0s 47ms/step - loss: 0.6180 - accuracy: 0.6792 - val_loss: 0.6293 - val_
accuracy: 0.662
5
Epoch 46/400
8/8 [==============================] - 0s 51ms/step - loss: 0.6103 - accuracy: 0.6722 - val_loss: 0.6664 - val_
accuracy: 0.550
0
Epoch 47/400
8/8 [==============================] - 0s 48ms/step - loss: 0.6155 - accuracy: 0.6556 - val_loss: 0.6756 - val_
accuracy: 0.575
0
Epoch 48/400
8/8 [==============================] - 0s 52ms/step - loss: 0.6076 - accuracy: 0.6542 - val_loss: 0.7372 - val_
accuracy: 0.550
0
Epoch 49/400
8/8 [==============================] - 0s 51ms/step - loss: 0.6165 - accuracy: 0.6569 - val_loss: 0.6587 - val_
accuracy: 0.587
5
Epoch 50/400
8/8 [==============================] - 0s 55ms/step - loss: 0.6135 - accuracy: 0.6597 - val_loss: 0.6283 - val_
accuracy: 0.637
5
Epoch 51/400
8/8 [==============================] - 0s 52ms/step - loss: 0.6119 - accuracy: 0.6694 - val_loss: 0.6467 - val_
accuracy: 0.637
5
Epoch 52/400
8/8 [==============================] - 0s 50ms/step - loss: 0.6091 - accuracy: 0.6597 - val_loss: 0.7107 - val_
accuracy: 0.575
0
Epoch 53/400
8/8 [==============================] - 0s 49ms/step - loss: 0.6023 - accuracy: 0.6889 - val_loss: 0.6361 - val_
accuracy: 0.662
5
Epoch 54/400
8/8 [==============================] - 1s 67ms/step - loss: 0.5984 - accuracy: 0.6889 - val_loss: 0.6254 - val_
accuracy: 0.662
5
Epoch 55/400
8/8 [==============================] - 0s 58ms/step - loss: 0.5967 - accuracy: 0.6972 - val_loss: 0.6758 - val_
accuracy: 0.537
5
Epoch 56/400
8/8 [==============================] - 1s 57ms/step - loss: 0.6421 - accuracy: 0.6250 - val_loss: 0.7476 - val_
accuracy: 0.550
0
Epoch 57/400
8/8 [==============================] - 0s 52ms/step - loss: 0.6120 - accuracy: 0.6722 - val_loss: 0.6774 - val_
accuracy: 0.537
5
Epoch 58/400
8/8 [==============================] - 0s 55ms/step - loss: 0.5929 - accuracy: 0.7014 - val_loss: 0.7176 - val_
accuracy: 0.575
0
Epoch 59/400
8/8 [==============================] - 0s 49ms/step - loss: 0.5983 - accuracy: 0.6875 - val_loss: 0.6388 - val_
accuracy: 0.600
0
Epoch 60/400
8/8 [==============================] - 0s 58ms/step - loss: 0.6069 - accuracy: 0.6583 - val_loss: 0.6622 - val_
accuracy: 0.575
0
Epoch 61/400
8/8 [==============================] - 1s 67ms/step - loss: 0.5846 - accuracy: 0.7028 - val_loss: 0.6228 - val_
accuracy: 0.625
0
Epoch 62/400
8/8 [==============================] - 0s 52ms/step - loss: 0.5926 - accuracy: 0.6875 - val_loss: 0.6362 - val_
accuracy: 0.600
0
Epoch 63/400
8/8 [==============================] - 0s 56ms/step - loss: 0.5860 - accuracy: 0.6931 - val_loss: 0.6212 - val_
accuracy: 0.637
5
Epoch 64/400
8/8 [==============================] - 0s 52ms/step - loss: 0.5777 - accuracy: 0.7069 - val_loss: 0.8355 - val_
accuracy: 0.537
5
Epoch 65/400
8/8 [==============================] - 1s 69ms/step - loss: 0.5971 - accuracy: 0.6778 - val_loss: 0.7197 - val_
accuracy: 0.550
0
Epoch 66/400
8/8 [==============================] - 1s 68ms/step - loss: 0.5993 - accuracy: 0.6639 - val_loss: 0.8742 - val_
accuracy: 0.525
0
Epoch 67/400
8/8 [==============================] - 0s 49ms/step - loss: 0.6232 - accuracy: 0.6528 - val_loss: 0.6205 - val_
accuracy: 0.687
5
Epoch 68/400
8/8 [==============================] - 0s 53ms/step - loss: 0.5771 - accuracy: 0.7125 - val_loss: 0.6331 - val_
accuracy: 0.600
0
Epoch 69/400
8/8 [==============================] - 0s 44ms/step - loss: 0.5959 - accuracy: 0.6667 - val_loss: 0.9506 - val_
accuracy: 0.500
0
Epoch 70/400
8/8 [==============================] - 0s 48ms/step - loss: 0.6205 - accuracy: 0.6597 - val_loss: 0.6197 - val_
accuracy: 0.662
5
Epoch 71/400
8/8 [==============================] - 0s 46ms/step - loss: 0.5736 - accuracy: 0.7028 - val_loss: 0.6209 - val_
accuracy: 0.687
5
Epoch 72/400
8/8 [==============================] - 0s 47ms/step - loss: 0.5764 - accuracy: 0.7000 - val_loss: 0.7568 - val_
accuracy: 0.562
5
Epoch 73/400
8/8 [==============================] - 0s 45ms/step - loss: 0.5979 - accuracy: 0.6708 - val_loss: 0.8001 - val_
accuracy: 0.550
0
Epoch 74/400
8/8 [==============================] - 0s 48ms/step - loss: 0.5946 - accuracy: 0.6722 - val_loss: 0.7058 - val_
accuracy: 0.587
5
Epoch 75/400
8/8 [==============================] - 0s 44ms/step - loss: 0.5783 - accuracy: 0.7083 - val_loss: 0.7063 - val_
accuracy: 0.600
0
Epoch 76/400
8/8 [==============================] - 0s 48ms/step - loss: 0.5780 - accuracy: 0.6931 - val_loss: 0.6295 - val_
accuracy: 0.612
5
Epoch 77/400
8/8 [==============================] - 0s 47ms/step - loss: 0.5666 - accuracy: 0.7222 - val_loss: 0.6184 - val_
accuracy: 0.650
0
Epoch 78/400
8/8 [==============================] - 0s 45ms/step - loss: 0.5833 - accuracy: 0.6875 - val_loss: 0.7509 - val_
accuracy: 0.537
5
Epoch 79/400
8/8 [==============================] - 0s 47ms/step - loss: 0.5918 - accuracy: 0.6889 - val_loss: 0.6912 - val_
accuracy: 0.600
0
Epoch 80/400
8/8 [==============================] - 0s 46ms/step - loss: 0.6018 - accuracy: 0.6542 - val_loss: 0.6202 - val_
accuracy: 0.675
0
Epoch 81/400
8/8 [==============================] - 0s 45ms/step - loss: 0.6036 - accuracy: 0.6583 - val_loss: 0.6932 - val_
accuracy: 0.587
5
Epoch 82/400
8/8 [==============================] - 0s 48ms/step - loss: 0.5927 - accuracy: 0.6903 - val_loss: 0.6143 - val_
accuracy: 0.687
5
Epoch 83/400
8/8 [==============================] - 0s 46ms/step - loss: 0.5639 - accuracy: 0.7181 - val_loss: 0.6123 - val_
accuracy: 0.712
5
Epoch 84/400
8/8 [==============================] - 0s 48ms/step - loss: 0.5746 - accuracy: 0.6958 - val_loss: 0.6424 - val_
accuracy: 0.637
5
Epoch 85/400
8/8 [==============================] - 0s 46ms/step - loss: 0.5787 - accuracy: 0.6958 - val_loss: 0.9297 - val_
accuracy: 0.525
0
Epoch 86/400
8/8 [==============================] - 0s 47ms/step - loss: 0.6164 - accuracy: 0.6667 - val_loss: 0.7555 - val_
accuracy: 0.575
0
Epoch 87/400
8/8 [==============================] - 0s 50ms/step - loss: 0.5856 - accuracy: 0.6958 - val_loss: 0.6230 - val_
accuracy: 0.625
0
Epoch 88/400
8/8 [==============================] - 0s 51ms/step - loss: 0.5655 - accuracy: 0.7125 - val_loss: 0.6118 - val_
accuracy: 0.687
5
Epoch 89/400
8/8 [==============================] - 0s 56ms/step - loss: 0.5576 - accuracy: 0.7292 - val_loss: 0.7016 - val_
accuracy: 0.550
0
Epoch 90/400
8/8 [==============================] - 0s 49ms/step - loss: 0.5776 - accuracy: 0.6903 - val_loss: 0.8764 - val_
accuracy: 0.537
5
Epoch 91/400
8/8 [==============================] - 0s 52ms/step - loss: 0.5876 - accuracy: 0.6903 - val_loss: 0.6182 - val_
accuracy: 0.662
5
Epoch 92/400
8/8 [==============================] - 0s 61ms/step - loss: 0.5516 - accuracy: 0.7236 - val_loss: 0.6117 - val_
accuracy: 0.687
5
Epoch 93/400
8/8 [==============================] - 0s 59ms/step - loss: 0.5742 - accuracy: 0.7014 - val_loss: 0.6186 - val_
accuracy: 0.637
5
Epoch 94/400
8/8 [==============================] - 0s 57ms/step - loss: 0.5566 - accuracy: 0.7111 - val_loss: 0.6869 - val_
accuracy: 0.550
0
Epoch 95/400
8/8 [==============================] - 0s 52ms/step - loss: 0.5824 - accuracy: 0.6681 - val_loss: 0.6074 - val_
accuracy: 0.712
5
Epoch 96/400
8/8 [==============================] - 0s 53ms/step - loss: 0.5928 - accuracy: 0.6944 - val_loss: 0.6880 - val_
accuracy: 0.600
0
Epoch 97/400
8/8 [==============================] - 0s 52ms/step - loss: 0.5604 - accuracy: 0.7069 - val_loss: 0.6311 - val_
accuracy: 0.587
5
Epoch 98/400
8/8 [==============================] - 0s 56ms/step - loss: 0.5663 - accuracy: 0.7083 - val_loss: 0.7254 - val_
accuracy: 0.537
5
Epoch 99/400
8/8 [==============================] - 0s 52ms/step - loss: 0.5757 - accuracy: 0.7125 - val_loss: 0.6703 - val_
accuracy: 0.637
5
Epoch 100/400
8/8 [==============================] - 0s 59ms/step - loss: 0.5571 - accuracy: 0.7125 - val_loss: 0.6102 - val_
accuracy: 0.700
0
Epoch 101/400
8/8 [==============================] - 0s 54ms/step - loss: 0.5960 - accuracy: 0.6861 - val_loss: 0.6135 - val_
accuracy: 0.650
0
Epoch 102/400
8/8 [==============================] - 0s 62ms/step - loss: 0.5463 - accuracy: 0.7278 - val_loss: 0.7070 - val_
accuracy: 0.625
0
Epoch 103/400
8/8 [==============================] - 0s 56ms/step - loss: 0.5570 - accuracy: 0.7264 - val_loss: 0.6097 - val_
accuracy: 0.687
5
Epoch 104/400
8/8 [==============================] - 0s 59ms/step - loss: 0.5618 - accuracy: 0.6944 - val_loss: 0.6104 - val_
accuracy: 0.675
0
Epoch 105/400
8/8 [==============================] - 0s 53ms/step - loss: 0.5372 - accuracy: 0.7264 - val_loss: 0.6308 - val_
accuracy: 0.612
5
Epoch 106/400
8/8 [==============================] - 0s 56ms/step - loss: 0.5525 - accuracy: 0.7306 - val_loss: 0.6260 - val_
accuracy: 0.612
5
Epoch 107/400
8/8 [==============================] - 0s 54ms/step - loss: 0.5647 - accuracy: 0.7111 - val_loss: 0.6118 - val_
accuracy: 0.662
5
Epoch 108/400
8/8 [==============================] - 0s 54ms/step - loss: 0.5422 - accuracy: 0.7389 - val_loss: 0.6106 - val_
accuracy: 0.700
0
Epoch 109/400
8/8 [==============================] - 0s 56ms/step - loss: 0.5305 - accuracy: 0.7361 - val_loss: 0.6087 - val_
accuracy: 0.675
0
Epoch 110/400
8/8 [==============================] - 0s 61ms/step - loss: 0.5586 - accuracy: 0.7250 - val_loss: 0.7331 - val_
accuracy: 0.537
5
 - ETA: 0s - loss: 0.5551 - accuracy: 0.731
Epoch 111/400
8/8 [==============================] - 0s 56ms/step - loss: 0.5726 - accuracy: 0.6653 - val_loss: 0.6089 - val_
accuracy: 0.687
5
Epoch 112/400
8/8 [==============================] - 0s 54ms/step - loss: 0.5387 - accuracy: 0.7292 - val_loss: 0.6215 - val_
accuracy: 0.550
0
Epoch 113/400
8/8 [==============================] - 0s 55ms/step - loss: 0.5955 - accuracy: 0.6833 - val_loss: 0.6577 - val_
accuracy: 0.650
0
Epoch 114/400
8/8 [==============================] - 0s 61ms/step - loss: 0.5458 - accuracy: 0.7181 - val_loss: 0.6771 - val_
accuracy: 0.637
5
Epoch 115/400
8/8 [==============================] - 0s 54ms/step - loss: 0.5532 - accuracy: 0.7167 - val_loss: 0.6361 - val_
accuracy: 0.650
0
Epoch 116/400
8/8 [==============================] - 0s 57ms/step - loss: 0.5429 - accuracy: 0.7361 - val_loss: 0.6153 - val_
accuracy: 0.662
5
Epoch 117/400
8/8 [==============================] - 0s 56ms/step - loss: 0.5390 - accuracy: 0.7278 - val_loss: 0.7255 - val_
accuracy: 0.625
0
Epoch 118/400
8/8 [==============================] - 1s 65ms/step - loss: 0.5284 - accuracy: 0.7444 - val_loss: 0.6234 - val_
accuracy: 0.612
5
Epoch 119/400
8/8 [==============================] - 1s 90ms/step - loss: 0.5481 - accuracy: 0.7056 - val_loss: 0.6504 - val_
accuracy: 0.650
0
Epoch 120/400
8/8 [==============================] - 0s 60ms/step - loss: 0.5281 - accuracy: 0.7514 - val_loss: 0.6702 - val_
accuracy: 0.650
0
Epoch 121/400
8/8 [==============================] - 0s 62ms/step - loss: 0.5580 - accuracy: 0.7208 - val_loss: 0.6136 - val_
accuracy: 0.637
5
Epoch 122/400
8/8 [==============================] - 1s 67ms/step - loss: 0.5323 - accuracy: 0.7250 - val_loss: 0.6122 - val_
accuracy: 0.687
5
Epoch 123/400
8/8 [==============================] - 1s 68ms/step - loss: 0.5371 - accuracy: 0.7347 - val_loss: 0.6305 - val_
accuracy: 0.650
0
Epoch 124/400
8/8 [==============================] - 1s 67ms/step - loss: 0.5337 - accuracy: 0.7222 - val_loss: 0.6201 - val_
accuracy: 0.612
5
Epoch 125/400
8/8 [==============================] - ETA: 0s - loss: 0.5305 - accuracy: 0.731
9
 - 0s 61ms/step - loss: 0.5305 - accuracy: 0.7319 - val_loss: 0.6192 - val_accuracy: 0.6750
Epoch 126/400
8/8 [==============================] - 0s 55ms/step - loss: 0.5259 - accuracy: 0.7361 - val_loss: 0.7472 - val_
accuracy: 0.550
0
Epoch 127/400
8/8 [==============================] - 0s 55ms/step - loss: 0.5552 - accuracy: 0.7014 - val_loss: 0.6439 - val_
accuracy: 0.650
0
Epoch 128/400
8/8 [==============================] - 1s 75ms/step - loss: 0.5267 - accuracy: 0.7389 - val_loss: 0.6381 - val_
accuracy: 0.600
0
Epoch 129/400
8/8 [==============================] - 0s 53ms/step - loss: 0.5282 - accuracy: 0.7431 - val_loss: 0.8102 - val_
accuracy: 0.575
0
Epoch 130/400
8/8 [==============================] - 0s 57ms/step - loss: 0.5522 - accuracy: 0.7167 - val_loss: 0.6442 - val_
accuracy: 0.662
5
Epoch 131/400
8/8 [==============================] - 1s 66ms/step - loss: 0.5215 - accuracy: 0.7458 - val_loss: 0.5979 - val_
accuracy: 0.725
0
Epoch 132/400
8/8 [==============================] - 1s 65ms/step - loss: 0.5105 - accuracy: 0.7639 - val_loss: 0.5988 - val_
accuracy: 0.700
0
Epoch 133/400
8/8 [==============================] - 1s 68ms/step - loss: 0.5319 - accuracy: 0.7264 - val_loss: 0.6161 - val_
accuracy: 0.687
5
Epoch 134/400
8/8 [==============================] - 1s 62ms/step - loss: 0.5175 - accuracy: 0.7431 - val_loss: 0.6479 - val_
accuracy: 0.587
5
Epoch 135/400
8/8 [==============================] - 1s 65ms/step - loss: 0.5173 - accuracy: 0.7556 - val_loss: 0.7333 - val_
accuracy: 0.550
0
Epoch 136/400
8/8 [==============================] - 0s 64ms/step - loss: 0.5343 - accuracy: 0.7208 - val_loss: 0.7229 - val_
accuracy: 0.562
5
Epoch 137/400
8/8 [==============================] - 1s 69ms/step - loss: 0.5846 - accuracy: 0.6861 - val_loss: 0.6544 - val_
accuracy: 0.575
0
Epoch 138/400
8/8 [==============================] - 1s 88ms/step - loss: 0.5182 - accuracy: 0.7444 - val_loss: 0.6223 - val_
accuracy: 0.662
5
Epoch 139/400
8/8 [==============================] - 1s 73ms/step - loss: 0.5177 - accuracy: 0.7542 - val_loss: 0.6060 - val_
accuracy: 0.662
5
Epoch 140/400
8/8 [==============================] - 1s 67ms/step - loss: 0.5068 - accuracy: 0.7597 - val_loss: 0.6109 - val_
accuracy: 0.700
0
Epoch 141/400
8/8 [==============================] - 1s 64ms/step - loss: 0.5637 - accuracy: 0.6903 - val_loss: 0.7234 - val_
accuracy: 0.575
0
Epoch 142/400
8/8 [==============================] - 1s 74ms/step - loss: 0.5217 - accuracy: 0.7486 - val_loss: 0.6162 - val_
accuracy: 0.675
0
Epoch 143/400
8/8 [==============================] - 0s 60ms/step - loss: 0.5249 - accuracy: 0.7389 - val_loss: 0.6635 - val_
accuracy: 0.675
0
Epoch 144/400
8/8 [==============================] - 0s 50ms/step - loss: 0.5069 - accuracy: 0.7486 - val_loss: 0.7264 - val_
accuracy: 0.587
5
Epoch 145/400
8/8 [==============================] - 0s 49ms/step - loss: 0.5152 - accuracy: 0.7389 - val_loss: 0.6176 - val_
accuracy: 0.625
0
Epoch 146/400
8/8 [==============================] - 0s 57ms/step - loss: 0.5277 - accuracy: 0.7389 - val_loss: 0.5960 - val_
accuracy: 0.687
5
Epoch 147/400
8/8 [==============================] - 0s 52ms/step - loss: 0.5092 - accuracy: 0.7458 - val_loss: 0.7911 - val_
accuracy: 0.537
5
Epoch 148/400
8/8 [==============================] - 0s 49ms/step - loss: 0.5375 - accuracy: 0.7292 - val_loss: 0.5914 - val_
accuracy: 0.712
5
Epoch 149/400
8/8 [==============================] - 0s 57ms/step - loss: 0.5182 - accuracy: 0.7444 - val_loss: 0.5998 - val_
accuracy: 0.700
0
Epoch 150/400
8/8 [==============================] - 0s 59ms/step - loss: 0.5252 - accuracy: 0.7375 - val_loss: 0.7962 - val_
accuracy: 0.575
0
Epoch 151/400
8/8 [==============================] - 1s 66ms/step - loss: 0.5644 - accuracy: 0.7153 - val_loss: 0.6187 - val_
accuracy: 0.600
0
Epoch 152/400
8/8 [==============================] - 0s 53ms/step - loss: 0.5160 - accuracy: 0.7486 - val_loss: 0.6183 - val_
accuracy: 0.675
0
Epoch 153/400
8/8 [==============================] - 0s 58ms/step - loss: 0.4962 - accuracy: 0.7792 - val_loss: 0.6144 - val_
accuracy: 0.6375
Epoch 154/400
8/8 [==============================] - 0s 64ms/step - loss: 0.5102 - accuracy: 0.7514 - val_loss: 0.7038 - val_
accuracy: 0.575
0
Epoch 155/400
8/8 [==============================] - 0s 55ms/step - loss: 0.5298 - accuracy: 0.7361 - val_loss: 0.6204 - val_
accuracy: 0.637
5
Epoch 156/400
8/8 [==============================] - ETA: 0s - loss: 0.5015 - accuracy: 0.764
3
 - 0s 59ms/step - loss: 0.5013 - accuracy: 0.7639 - val_loss: 0.6402 - val_accuracy: 0.6750
Epoch 157/400
8/8 [==============================] - 0s 57ms/step - loss: 0.5275 - accuracy: 0.7375 - val_loss: 0.6542 - val_
accuracy: 0.587
5
Epoch 158/400
8/8 [==============================] - ETA: 0s - loss: 0.5006 - accuracy: 0.754
3
 - 0s 59ms/step - loss: 0.5062 - accuracy: 0.7486 - val_loss: 0.9713 - val_accuracy: 0.5250
Epoch 159/400
8/8 [==============================] - ETA: 0s - loss: 0.6130 - accuracy: 0.698
6
 - 0s 56ms/step - loss: 0.6093 - accuracy: 0.7000 - val_loss: 0.5919 - val_accuracy: 0.6875
Epoch 160/400
8/8 [==============================] - 1s 75ms/step - loss: 0.5012 - accuracy: 0.7514 - val_loss: 0.5852 - val_
accuracy: 0.725
0
Epoch 161/400
8/8 [==============================] - 1s 79ms/step - loss: 0.4941 - accuracy: 0.7708 - val_loss: 0.7111 - val_
accuracy: 0.587
5
Epoch 162/400
8/8 [==============================] - 1s 64ms/step - loss: 0.5061 - accuracy: 0.7681 - val_loss: 0.6029 - val_
accuracy: 0.700
0
Epoch 163/400
8/8 [==============================] - 0s 59ms/step - loss: 0.4966 - accuracy: 0.7611 - val_loss: 0.5833 - val_
accuracy: 0.737
5
 - ETA: 0s - loss: 0.5063 - accuracy: 0.723
Epoch 164/400
8/8 [==============================] - 0s 62ms/step - loss: 0.5039 - accuracy: 0.7472 - val_loss: 0.5899 - val_
accuracy: 0.725
0
Epoch 165/400
8/8 [==============================] - 0s 61ms/step - loss: 0.5282 - accuracy: 0.7361 - val_loss: 0.7468 - val_
accuracy: 0.625
0
Epoch 166/400
8/8 [==============================] - 1s 74ms/step - loss: 0.5158 - accuracy: 0.7542 - val_loss: 0.6348 - val_
accuracy: 0.687
5
Epoch 167/400
8/8 [==============================] - 1s 75ms/step - loss: 0.5261 - accuracy: 0.7292 - val_loss: 0.6680 - val_
accuracy: 0.650
0
Epoch 168/400
8/8 [==============================] - 0s 58ms/step - loss: 0.4969 - accuracy: 0.7653 - val_loss: 0.5860 - val_
accuracy: 0.725
0
Epoch 169/400
8/8 [==============================] - 0s 53ms/step - loss: 0.4998 - accuracy: 0.7722 - val_loss: 0.5912 - val_
accuracy: 0.712
5
Epoch 170/400
8/8 [==============================] - 0s 60ms/step - loss: 0.4873 - accuracy: 0.7694 - val_loss: 0.6628 - val_
accuracy: 0.675
0
Epoch 171/400
8/8 [==============================] - 1s 74ms/step - loss: 0.5003 - accuracy: 0.7611 - val_loss: 0.6084 - val_
accuracy: 0.675
0
Epoch 172/400
8/8 [==============================] - 1s 80ms/step - loss: 0.4962 - accuracy: 0.7611 - val_loss: 0.6610 - val_
accuracy: 0.600
0
Epoch 173/400
8/8 [==============================] - 0s 60ms/step - loss: 0.5198 - accuracy: 0.7375 - val_loss: 0.5934 - val_
accuracy: 0.725
0
Epoch 174/400
8/8 [==============================] - 0s 59ms/step - loss: 0.5030 - accuracy: 0.7597 - val_loss: 0.5884 - val_
accuracy: 0.687
5
 - ETA: 0s - loss: 0.5007 - accuracy: 0.761
Epoch 175/400
8/8 [==============================] - 0s 56ms/step - loss: 0.5007 - accuracy: 0.7458 - val_loss: 0.5920 - val_
accuracy: 0.662
5
Epoch 176/400
8/8 [==============================] - 0s 63ms/step - loss: 0.4927 - accuracy: 0.7681 - val_loss: 0.6740 - val_
accuracy: 0.587
5
Epoch 177/400
8/8 [==============================] - 0s 61ms/step - loss: 0.5420 - accuracy: 0.7097 - val_loss: 1.0024 - val_
accuracy: 0.525
0
Epoch 178/400
8/8 [==============================] - 1s 69ms/step - loss: 0.5365 - accuracy: 0.7431 - val_loss: 0.5829 - val_
accuracy: 0.737
5
Epoch 179/400
8/8 [==============================] - 1s 70ms/step - loss: 0.4803 - accuracy: 0.7917 - val_loss: 0.6953 - val_
accuracy: 0.600
0
 - ETA: 0s - loss: 0.4951 - accuracy: 0.767
Epoch 180/400
8/8 [==============================] - 1s 67ms/step - loss: 0.5102 - accuracy: 0.7361 - val_loss: 0.6157 - val_
accuracy: 0.637
5
Epoch 181/400
8/8 [==============================] - 1s 78ms/step - loss: 0.4769 - accuracy: 0.7889 - val_loss: 0.7419 - val_
accuracy: 0.600
0
Epoch 182/400
8/8 [==============================] - 1s 88ms/step - loss: 0.5254 - accuracy: 0.7486 - val_loss: 0.5877 - val_
accuracy: 0.725
0
Epoch 183/400
8/8 [==============================] - 1s 70ms/step - loss: 0.4868 - accuracy: 0.7847 - val_loss: 0.5974 - val_
accuracy: 0.662
5
Epoch 184/400
8/8 [==============================] - 0s 52ms/step - loss: 0.4881 - accuracy: 0.7792 - val_loss: 0.6891 - val_
accuracy: 0.600
0
Epoch 185/400
8/8 [==============================] - 0s 58ms/step - loss: 0.4902 - accuracy: 0.7736 - val_loss: 0.6142 - val_
accuracy: 0.650
0
Epoch 186/400
8/8 [==============================] - 1s 64ms/step - loss: 0.4735 - accuracy: 0.7889 - val_loss: 0.6421 - val_
accuracy: 0.612
5
Epoch 187/400
8/8 [==============================] - 1s 67ms/step - loss: 0.4843 - accuracy: 0.7597 - val_loss: 0.6541 - val_
```

```
accuracy: 0.612
5

Epoch 188/400
8/8 [==============================] - 0s 53ms/step - loss: 0.4877 - accuracy: 0.7681 - val_loss: 0.5859 - val_
accuracy: 0.687
5

Epoch 189/400
8/8 [==============================] - 0s 51ms/step - loss: 0.4892 - accuracy: 0.7819 - val_loss: 0.5829 - val_
accuracy: 0.712
5

Epoch 190/400
8/8 [==============================] - 0s 63ms/step - loss: 0.4708 - accuracy: 0.7931 - val_loss: 0.7129 - val_
accuracy: 0.587
5

Epoch 191/400
8/8 [==============================] - 1s 77ms/step - loss: 0.4792 - accuracy: 0.7847 - val_loss: 0.5801 - val_
accuracy: 0.687
5

Epoch 192/400
8/8 [==============================] - 1s 67ms/step - loss: 0.4722 - accuracy: 0.7917 - val_loss: 0.5805 - val_
accuracy: 0.675
0

Epoch 193/400
8/8 [==============================] - 1s 68ms/step - loss: 0.4716 - accuracy: 0.7667 - val_loss: 0.6061 - val_
accuracy: 0.650
0

Epoch 194/400
8/8 [==============================] - 1s 67ms/step - loss: 0.5169 - accuracy: 0.7250 - val_loss: 0.6748 - val_
accuracy: 0.600
0

Epoch 195/400
8/8 [==============================] - 0s 52ms/step - loss: 0.4761 - accuracy: 0.7778 - val_loss: 0.6482 - val_
accuracy: 0.675
0

Epoch 196/400
8/8 [==============================] - 1s 70ms/step - loss: 0.4827 - accuracy: 0.7750 - val_loss: 0.5831 - val_
accuracy: 0.725
0

Epoch 197/400
8/8 [==============================] - 0s 59ms/step - loss: 0.4664 - accuracy: 0.7958 - val_loss: 0.5972 - val_
accuracy: 0.700
0

Epoch 198/400
8/8 [==============================] - 1s 62ms/step - loss: 0.4906 - accuracy: 0.7597 - val_loss: 0.6650 - val_
accuracy: 0.600
0

Epoch 199/400
8/8 [==============================] - 1s 79ms/step - loss: 0.4692 - accuracy: 0.7847 - val_loss: 0.5773 - val_
accuracy: 0.750
0

Epoch 200/400
8/8 [==============================] - 1s 86ms/step - loss: 0.4595 - accuracy: 0.8000 - val_loss: 0.5975 - val_
accuracy: 0.675
0

Epoch 201/400
8/8 [==============================] - 1s 80ms/step - loss: 0.4689 - accuracy: 0.7764 - val_loss: 0.5774 - val_
accuracy: 0.737
5

Epoch 202/400
8/8 [==============================] - 1s 90ms/step - loss: 0.4572 - accuracy: 0.8042 - val_loss: 0.5803 - val_
accuracy: 0.750
0

Epoch 203/400
8/8 [==============================] - 1s 107ms/step - loss: 0.4847 - accuracy: 0.7722 - val_loss: 0.5803 - val
_accuracy: 0.750
0

Epoch 204/400
8/8 [==============================] - 1s 76ms/step - loss: 0.4747 - accuracy: 0.7819 - val_loss: 0.6038 - val_
accuracy: 0.662
5

Epoch 205/400
8/8 [==============================] - 1s 100ms/step - loss: 0.4600 - accuracy: 0.7889 - val_loss: 0.6912 - val
_accuracy: 0.575
0

Epoch 206/400
8/8 [==============================] - 1s 64ms/step - loss: 0.4808 - accuracy: 0.7778 - val_loss: 0.5761 - val_
accuracy: 0.687
5

Epoch 207/400
8/8 [==============================] - 0s 54ms/step - loss: 0.4662 - accuracy: 0.7833 - val_loss: 0.5992 - val_
accuracy: 0.662
5

Epoch 208/400
8/8 [==============================] - 0s 62ms/step - loss: 0.4686 - accuracy: 0.7736 - val_loss: 0.6707 - val_
accuracy: 0.650
0

Epoch 209/400
8/8 [==============================] - 0s 61ms/step - loss: 0.4849 - accuracy: 0.7500 - val_loss: 0.5719 - val_
accuracy: 0.762
5

Epoch 210/400
8/8 [==============================] - 1s 72ms/step - loss: 0.4862 - accuracy: 0.7653 - val_loss: 0.6561 - val_
accuracy: 0.612
5

Epoch 211/400
8/8 [==============================] - 0s 52ms/step - loss: 0.4707 - accuracy: 0.7778 - val_loss: 0.6157 - val_
accuracy: 0.675
0

Epoch 212/400
8/8 [==============================] - 0s 60ms/step - loss: 0.4571 - accuracy: 0.7958 - val_loss: 0.7334 - val_
accuracy: 0.637
5
 - ETA: 0s - loss: 0.4521 - accuracy: 0.801
3

Epoch 213/400
8/8 [==============================] - 0s 60ms/step - loss: 0.4685 - accuracy: 0.7764 - val_loss: 0.5776 - val_
accuracy: 0.687
5

Epoch 214/400
8/8 [==============================] - 0s 61ms/step - loss: 0.5048 - accuracy: 0.7472 - val_loss: 0.6047 - val_
accuracy: 0.625
0

Epoch 215/400
8/8 [==============================] - 1s 173ms/step - loss: 0.4602 - accuracy: 0.8028 - val_loss: 0.5963 - val
_accuracy: 0.650
0

Epoch 216/400
8/8 [==============================] - 0s 56ms/step - loss: 0.4898 - accuracy: 0.7611 - val_loss: 0.6556 - val_
accuracy: 0.637
5

Epoch 217/400
8/8 [==============================] - 1s 77ms/step - loss: 0.4524 - accuracy: 0.8167 - val_loss: 0.5865 - val_
accuracy: 0.725
0

Epoch 218/400
8/8 [==============================] - 1s 68ms/step - loss: 0.4568 - accuracy: 0.7986 - val_loss: 0.6256 - val_
accuracy: 0.637
5

Epoch 219/400
8/8 [==============================] - 0s 55ms/step - loss: 0.4614 - accuracy: 0.8000 - val_loss: 0.5839 - val_
accuracy: 0.687
5

Epoch 220/400
8/8 [==============================] - 0s 62ms/step - loss: 0.4681 - accuracy: 0.7819 - val_loss: 0.5790 - val_
accuracy: 0.725
0

Epoch 221/400
8/8 [==============================] - 1s 62ms/step - loss: 0.4475 - accuracy: 0.8181 - val_loss: 0.7614 - val_
accuracy: 0.650
0

Epoch 222/400
8/8 [==============================] - 0s 50ms/step - loss: 0.4672 - accuracy: 0.7875 - val_loss: 0.5828 - val_
accuracy: 0.712
5

Epoch 223/400
8/8 [==============================] - 1s 72ms/step - loss: 0.4555 - accuracy: 0.8056 - val_loss: 0.5654 - val_
accuracy: 0.662
5

Epoch 224/400
8/8 [==============================] - 1s 79ms/step - loss: 0.4598 - accuracy: 0.7903 - val_loss: 0.5710 - val_
accuracy: 0.737
5

Epoch 225/400
8/8 [==============================] - 1s 81ms/step - loss: 0.4450 - accuracy: 0.8069 - val_loss: 0.5733 - val_
accuracy: 0.750
0

Epoch 226/400
8/8 [==============================] - 1s 75ms/step - loss: 0.4443 - accuracy: 0.8056 - val_loss: 0.8772 - val_
accuracy: 0.550
0

Epoch 227/400
8/8 [==============================] - 1s 75ms/step - loss: 0.5274 - accuracy: 0.7528 - val_loss: 0.6441 - val_
accuracy: 0.650
0

Epoch 228/400
8/8 [==============================] - 1s 67ms/step - loss: 0.4521 - accuracy: 0.7875 - val_loss: 0.6344 - val_
accuracy: 0.650
0

Epoch 229/400
8/8 [==============================] - 0s 57ms/step - loss: 0.4732 - accuracy: 0.7736 - val_loss: 0.5905 - val_
accuracy: 0.6625 - ETA: 0s - loss: 0.4875 - accuracy: 0.785
0

Epoch 230/400
8/8 [==============================] - 1s 85ms/step - loss: 0.4415 - accuracy: 0.8222 - val_loss: 0.5903 - val_
accuracy: 0.675
0

Epoch 231/400
8/8 [==============================] - 1s 86ms/step - loss: 0.4371 - accuracy: 0.8083 - val_loss: 0.7055 - val_
accuracy: 0.650
0

Epoch 232/400
8/8 [==============================] - 1s 80ms/step - loss: 0.4778 - accuracy: 0.7722 - val_loss: 0.5851 - val_
accuracy: 0.737
5

Epoch 233/400
8/8 [==============================] - 1s 89ms/step - loss: 0.4813 - accuracy: 0.8056 - val_loss: 0.6316 - val_
accuracy: 0.662
5

Epoch 234/400
8/8 [==============================] - 1s 70ms/step - loss: 0.4370 - accuracy: 0.8042 - val_loss: 0.6093 - val_
accuracy: 0.625
0

Epoch 235/400
8/8 [==============================] - 1s 96ms/step - loss: 0.4559 - accuracy: 0.8028 - val_loss: 0.5864 - val_
accuracy: 0.675
0

Epoch 236/400
8/8 [==============================] - 1s 76ms/step - loss: 0.4794 - accuracy: 0.7778 - val_loss: 0.6081 - val_
accuracy: 0.625
0

Epoch 237/400
8/8 [==============================] - 0s 63ms/step - loss: 0.4479 - accuracy: 0.7903 - val_loss: 0.5835 - val_
accuracy: 0.737
5

Epoch 238/400
8/8 [==============================] - 1s 73ms/step - loss: 0.4359 - accuracy: 0.8111 - val_loss: 0.5817 - val_
accuracy: 0.737
5

Epoch 239/400
8/8 [==============================] - 1s 70ms/step - loss: 0.4391 - accuracy: 0.8139 - val_loss: 0.5761 - val_
accuracy: 0.700
0

Epoch 240/400
8/8 [==============================] - 1s 70ms/step - loss: 0.4644 - accuracy: 0.7694 - val_loss: 0.7841 - val_
accuracy: 0.575
0

Epoch 241/400
8/8 [==============================] - 1s 79ms/step - loss: 0.4951 - accuracy: 0.7694 - val_loss: 0.6554 - val_
accuracy: 0.662
5

Epoch 242/400
8/8 [==============================] - 1s 68ms/step - loss: 0.4605 - accuracy: 0.8056 - val_loss: 0.6107 - val_
accuracy: 0.650
0

Epoch 243/400
8/8 [==============================] - 1s 79ms/step - loss: 0.4381 - accuracy: 0.8167 - val_loss: 0.5706 - val_
accuracy: 0.712
5

Epoch 244/400
8/8 [==============================] - 1s 70ms/step - loss: 0.4628 - accuracy: 0.7972 - val_loss: 0.6297 - val_
accuracy: 0.637
5

Epoch 245/400
8/8 [==============================] - 1s 75ms/step - loss: 0.4357 - accuracy: 0.8250 - val_loss: 0.5981 - val_
accuracy: 0.637
5

Epoch 246/400
8/8 [==============================] - 1s 81ms/step - loss: 0.4715 - accuracy: 0.7875 - val_loss: 0.5972 - val_
accuracy: 0.637
5

Epoch 247/400
8/8 [==============================] - 1s 71ms/step - loss: 0.4347 - accuracy: 0.8167 - val_loss: 0.5704 - val_
accuracy: 0.750
0

Epoch 248/400
8/8 [==============================] - 1s 73ms/step - loss: 0.4450 - accuracy: 0.8083 - val_loss: 0.5740 - val_
accuracy: 0.700
0

Epoch 249/400
8/8 [==============================] - 1s 77ms/step - loss: 0.4303 - accuracy: 0.8208 - val_loss: 0.5716 - val_
accuracy: 0.750
0

Epoch 250/400
8/8 [==============================] - 1s 100ms/step - loss: 0.4234 - accuracy: 0.8375 - val_loss: 0.8216 - val
_accuracy: 0.600
0

Epoch 251/400
8/8 [==============================] - 1s 72ms/step - loss: 0.4968 - accuracy: 0.7736 - val_loss: 0.9705 - val_
accuracy: 0.562
5

Epoch 252/400
8/8 [==============================] - 1s 86ms/step - loss: 0.5441 - accuracy: 0.7556 - val_loss: 0.6971 - val_
accuracy: 0.675
0

Epoch 253/400
8/8 [==============================] - 1s 73ms/step - loss: 0.4486 - accuracy: 0.8181 - val_loss: 0.8367 - val_
accuracy: 0.575
0

Epoch 254/400
8/8 [==============================] - 0s 56ms/step - loss: 0.4775 - accuracy: 0.7847 - val_loss: 0.6370 - val_
accuracy: 0.637
5

Epoch 255/400
8/8 [==============================] - 0s 53ms/step - loss: 0.4474 - accuracy: 0.7944 - val_loss: 0.6335 - val_
accuracy: 0.650
0

Epoch 256/400
8/8 [==============================] - 0s 53ms/step - loss: 0.4651 - accuracy: 0.7792 - val_loss: 0.6222 - val_
accuracy: 0.662
5

Epoch 257/400
8/8 [==============================] - 0s 49ms/step - loss: 0.4376 - accuracy: 0.8181 - val_loss: 0.5729 - val_
accuracy: 0.700
0

Epoch 258/400
8/8 [==============================] - 0s 60ms/step - loss: 0.4829 - accuracy: 0.7667 - val_loss: 0.6370 - val_
accuracy: 0.662
5

Epoch 259/400
8/8 [==============================] - 0s 58ms/step - loss: 0.4242 - accuracy: 0.8306 - val_loss: 0.5639 - val_
accuracy: 0.725
0

Epoch 260/400
8/8 [==============================] - 0s 60ms/step - loss: 0.4348 - accuracy: 0.8222 - val_loss: 0.5833 - val_
accuracy: 0.675
0

Epoch 261/400
8/8 [==============================] - 1s 79ms/step - loss: 0.4564 - accuracy: 0.7972 - val_loss: 0.5976 - val_
accuracy: 0.687
5

Epoch 262/400
8/8 [==============================] - 0s 59ms/step - loss: 0.4268 - accuracy: 0.8194 - val_loss: 0.5838 - val_
accuracy: 0.725
0

Epoch 263/400
8/8 [==============================] - 1s 72ms/step - loss: 0.4290 - accuracy: 0.8278 - val_loss: 0.5845 - val_
accuracy: 0.725
0

Epoch 264/400
8/8 [==============================] - 1s 70ms/step - loss: 0.4291 - accuracy: 0.8236 - val_loss: 0.7220 - val_
accuracy: 0.600
0

Epoch 265/400
8/8 [==============================] - 1s 63ms/step - loss: 0.4597 - accuracy: 0.7917 - val_loss: 0.5659 - val_
accuracy: 0.725
0

Epoch 266/400
8/8 [==============================] - 1s 69ms/step - loss: 0.4180 - accuracy: 0.8292 - val_loss: 0.6887 - val_
accuracy: 0.662
5

Epoch 267/400
8/8 [==============================] - 1s 65ms/step - loss: 0.4445 - accuracy: 0.8097 - val_loss: 0.7730 - val_
accuracy: 0.575
0

Epoch 268/400
8/8 [==============================] - 0s 54ms/step - loss: 0.4660 - accuracy: 0.7764 - val_loss: 0.6794 - val_
accuracy: 0.662
5

Epoch 269/400
8/8 [==============================] - 0s 60ms/step - loss: 0.4247 - accuracy: 0.8181 - val_loss: 0.5832 - val_
accuracy: 0.675
0

Epoch 270/400
8/8 [==============================] - 0s 52ms/step - loss: 0.4222 - accuracy: 0.8306 - val_loss: 0.6304 - val_
accuracy: 0.650
0

Epoch 271/400
8/8 [==============================] - 0s 54ms/step - loss: 0.4593 - accuracy: 0.7889 - val_loss: 0.5720 - val_
accuracy: 0.725
0

Epoch 272/400
8/8 [==============================] - 0s 57ms/step - loss: 0.4218 - accuracy: 0.8292 - val_loss: 0.6070 - val_
accuracy: 0.662
5

Epoch 273/400
8/8 [==============================] - 0s 50ms/step - loss: 0.4246 - accuracy: 0.8083 - val_loss: 0.6234 - val_
accuracy: 0.675
0

Epoch 274/400
8/8 [==============================] - 0s 52ms/step - loss: 0.4249 - accuracy: 0.8264 - val_loss: 0.6317 - val_
accuracy: 0.662
5

Epoch 275/400
8/8 [==============================] - 0s 51ms/step - loss: 0.4100 - accuracy: 0.8250 - val_loss: 0.5622 - val_
accuracy: 0.750
0

Epoch 276/400
8/8 [==============================] - 0s 49ms/step - loss: 0.4180 - accuracy: 0.8347 - val_loss: 0.5867 - val_
accuracy: 0.712
5

Epoch 277/400
8/8 [==============================] - 0s 52ms/step - loss: 0.4074 - accuracy: 0.8444 - val_loss: 0.7570 - val_
accuracy: 0.575
0

Epoch 278/400
8/8 [==============================] - 0s 52ms/step - loss: 0.4226 - accuracy: 0.8347 - val_loss: 0.5583 - val_
accuracy: 0.750
0

Epoch 279/400
8/8 [==============================] - 0s 50ms/step - loss: 0.4101 - accuracy: 0.8431 - val_loss: 0.7097 - val_
accuracy: 0.6625 - ETA: 0s - loss: 0.4172 - accuracy: 0.830
0

Epoch 280/400
8/8 [==============================] - 0s 49ms/step - loss: 0.4259 - accuracy: 0.8167 - val_loss: 0.5632 - val_
accuracy: 0.712
5

Epoch 281/400
8/8 [==============================] - 0s 49ms/step - loss: 0.4176 - accuracy: 0.8139 - val_loss: 0.5572 - val_
accuracy: 0.750
0

Epoch 282/400
8/8 [==============================] - 0s 55ms/step - loss: 0.4203 - accuracy: 0.8250 - val_loss: 0.6074 - val_
accuracy: 0.687
5

Epoch 283/400
8/8 [==============================] - 0s 49ms/step - loss: 0.4095 - accuracy: 0.8306 - val_loss: 0.5917 - val_
accuracy: 0.662
5

Epoch 284/400
8/8 [==============================] - 1s 77ms/step - loss: 0.4065 - accuracy: 0.8514 - val_loss: 0.5666 - val_
accuracy: 0.725
0

Epoch 285/400
8/8 [==============================] - 0s 52ms/step - loss: 0.4131 - accuracy: 0.8222 - val_loss: 0.6660 - val_
accuracy: 0.650
0

Epoch 286/400
8/8 [==============================] - 1s 117ms/step - loss: 0.4277 - accuracy: 0.7986 - val_loss: 0.5596 - val
_accuracy: 0.762
5

Epoch 287/400
8/8 [==============================] - 1s 66ms/step - loss: 0.3987 - accuracy: 0.8361 - val_loss: 0.6107 - val_
accuracy: 0.675
0

Epoch 288/400
8/8 [==============================] - 0s 57ms/step - loss: 0.4070 - accuracy: 0.8333 - val_loss: 0.5679 - val_
accuracy: 0.725
0

Epoch 289/400
8/8 [==============================] - 1s 75ms/step - loss: 0.4498 - accuracy: 0.7944 - val_loss: 0.5815 - val_
accuracy: 0.725
0

Epoch 290/400
8/8 [==============================] - 0s 55ms/step - loss: 0.4010 - accuracy: 0.8514 - val_loss: 0.6507 - val_
accuracy: 0.650
0

Epoch 291/400
8/8 [==============================] - 1s 71ms/step - loss: 0.4317 - accuracy: 0.8042 - val_loss: 0.6054 - val_
accuracy: 0.650
0

Epoch 292/400
8/8 [==============================] - 1s 74ms/step - loss: 0.4065 - accuracy: 0.8306 - val_loss: 0.5684 - val_
accuracy: 0.725
0
 - ETA: 0s - loss: 0.4085 - accuracy: 0.830
Epoch 293/400
8/8 [==============================] - 1s 66ms/step - loss: 0.4410 - accuracy: 0.8097 - val_loss: 0.5636 - val_
accuracy: 0.762
5

Epoch 294/400
8/8 [==============================] - 1s 72ms/step - loss: 0.3957 - accuracy: 0.8569 - val_loss: 0.5742 - val_
accuracy: 0.725
0

Epoch 295/400
8/8 [==============================] - 1s 64ms/step - loss: 0.4010 - accuracy: 0.8347 - val_loss: 0.5600 - val_
accuracy: 0.737
5

Epoch 296/400
8/8 [==============================] - 0s 57ms/step - loss: 0.3937 - accuracy: 0.8556 - val_loss: 0.5638 - val_
accuracy: 0.750
0

Epoch 297/400
8/8 [==============================] - 0s 55ms/step - loss: 0.4207 - accuracy: 0.8403 - val_loss: 0.6345 - val_
accuracy: 0.662
5

Epoch 298/400
8/8 [==============================] - 0s 59ms/step - loss: 0.4212 - accuracy: 0.8111 - val_loss: 0.5618 - val_
accuracy: 0.762
5

Epoch 299/400
8/8 [==============================] - 0s 50ms/step - loss: 0.3917 - accuracy: 0.8542 - val_loss: 0.6186 - val_
accuracy: 0.687
5

Epoch 300/400
8/8 [==============================] - 0s 49ms/step - loss: 0.4131 - accuracy: 0.8292 - val_loss: 0.6168 - val_
accuracy: 0.687
5

Epoch 301/400
8/8 [==============================] - 0s 53ms/step - loss: 0.4199 - accuracy: 0.8153 - val_loss: 0.7335 - val_
accuracy: 0.637
5

Epoch 302/400
8/8 [==============================] - 0s 50ms/step - loss: 0.4554 - accuracy: 0.7792 - val_loss: 0.6150 - val_
accuracy: 0.675
0

Epoch 303/400
8/8 [==============================] - 0s 50ms/step - loss: 0.3979 - accuracy: 0.8542 - val_loss: 0.7497 - val_
accuracy: 0.600
0

Epoch 304/400
8/8 [==============================] - 0s 52ms/step - loss: 0.4441 - accuracy: 0.7556 - val_loss: 0.5935 - val_
accuracy: 0.687
5

Epoch 305/400
8/8 [==============================] - 0s 57ms/step - loss: 0.4004 - accuracy: 0.8389 - val_loss: 0.5667 - val_
accuracy: 0.700
0

Epoch 306/400
8/8 [==============================] - 0s 49ms/step - loss: 0.3889 - accuracy: 0.8625 - val_loss: 0.6252 - val_
accuracy: 0.675
0

Epoch 307/400
8/8 [==============================] - 0s 54ms/step - loss: 0.4218 - accuracy: 0.8042 - val_loss: 0.6249 - val_
accuracy: 0.675
0

Epoch 308/400
8/8 [==============================] - 0s 51ms/step - loss: 0.4133 - accuracy: 0.8208 - val_loss: 0.5656 - val_
accuracy: 0.687
5

Epoch 309/400
8/8 [==============================] - 0s 52ms/step - loss: 0.3985 - accuracy: 0.8403 - val_loss: 0.6417 - val_
accuracy: 0.650
0

Epoch 310/400
8/8 [==============================] - 0s 48ms/step - loss: 0.4088 - accuracy: 0.8083 - val_loss: 0.6036 - val_
accuracy: 0.675
0

Epoch 311/400
8/8 [==============================] - 0s 50ms/step - loss: 0.3920 - accuracy: 0.8611 - val_loss: 0.7658 - val_
accuracy: 0.625
0

Epoch 312/400
8/8 [==============================] - ETA: 0s - loss: 0.4559 - accuracy: 0.797
1
 - 0s 55ms/step - loss: 0.4528 - accuracy: 0.8014 - val_loss: 0.5652 - val_accuracy: 0.6750
Epoch 313/400
8/8 [==============================] - 0s 56ms/step - loss: 0.3908 - accuracy: 0.8472 - val_loss: 0.5953 - val_
accuracy: 0.700
0

Epoch 314/400
8/8 [==============================] - 0s 53ms/step - loss: 0.3883 - accuracy: 0.8528 - val_loss: 0.5636 - val_
accuracy: 0.737
5

Epoch 315/400
8/8 [==============================] - 0s 50ms/step - loss: 0.3982 - accuracy: 0.8278 - val_loss: 0.7829 - val_
accuracy: 0.637
5

Epoch 316/400
8/8 [==============================] - 0s 65ms/step - loss: 0.4175 - accuracy: 0.8278 - val_loss: 0.5599 - val_
accuracy: 0.712
5

Epoch 317/400
8/8 [==============================] - 0s 56ms/step - loss: 0.4033 - accuracy: 0.8375 - val_loss: 0.5561 - val_
accuracy: 0.775
0

Epoch 318/400
8/8 [==============================] - 0s 58ms/step - loss: 0.3842 - accuracy: 0.8542 - val_loss: 0.6092 - val_
accuracy: 0.687
5

Epoch 319/400
8/8 [==============================] - 1s 78ms/step - loss: 0.4023 - accuracy: 0.8292 - val_loss: 0.5629 - val_
accuracy: 0.700
0

Epoch 320/400
8/8 [==============================] - 0s 57ms/step - loss: 0.3897 - accuracy: 0.8444 - val_loss: 0.6516 - val_
accuracy: 0.650
0

Epoch 321/400
8/8 [==============================] - 0s 57ms/step - loss: 0.4202 - accuracy: 0.8111 - val_loss: 0.5581 - val_
accuracy: 0.687
5

Epoch 322/400
8/8 [==============================] - 0s 52ms/step - loss: 0.3995 - accuracy: 0.8389 - val_loss: 0.5538 - val_
accuracy: 0.725
0

Epoch 323/400
8/8 [==============================] - 0s 58ms/step - loss: 0.3817 - accuracy: 0.8556 - val_loss: 0.5561 - val_
accuracy: 0.775
0

Epoch 324/400
8/8 [==============================] - 1s 65ms/step - loss: 0.3816 - accuracy: 0.8431 - val_loss: 0.5616 - val_
accuracy: 0.750
0

Epoch 325/400
8/8 [==============================] - 1s 67ms/step - loss: 0.3804 - accuracy: 0.8569 - val_loss: 0.7012 - val_
accuracy: 0.675
0

Epoch 326/400
8/8 [==============================] - 1s 133ms/step - loss: 0.3990 - accuracy: 0.8361 - val_loss: 0.8934 - val
_accuracy: 0.562
5

Epoch 327/400
8/8 [==============================] - 1s 90ms/step - loss: 0.4173 - accuracy: 0.8236 - val_loss: 0.6100 - val_
accuracy: 0.687
5

Epoch 328/400
8/8 [==============================] - 0s 60ms/step - loss: 0.3974 - accuracy: 0.8306 - val_loss: 0.5740 - val_
accuracy: 0.687
5

Epoch 329/400
8/8 [==============================] - 0s 59ms/step - loss: 0.4068 - accuracy: 0.8194 - val_loss: 0.5657 - val_
accuracy: 0.737
5

Epoch 330/400
8/8 [==============================] - 0s 52ms/step - loss: 0.3789 - accuracy: 0.8556 - val_loss: 0.5545 - val_
accuracy: 0.750
0

Epoch 331/400
8/8 [==============================] - 0s 54ms/step - loss: 0.3813 - accuracy: 0.8472 - val_loss: 0.5598 - val_
accuracy: 0.775
0
 - ETA: 0s - loss: 0.3730 - accuracy: 0.863
3

Epoch 332/400
8/8 [==============================] - 0s 52ms/step - loss: 0.3729 - accuracy: 0.8694 - val_loss: 0.5753 - val_
accuracy: 0.700
0

Epoch 333/400
8/8 [==============================] - 0s 52ms/step - loss: 0.3761 - accuracy: 0.8361 - val_loss: 0.5725 - val_
accuracy: 0.712
5

Epoch 334/400
8/8 [==============================] - 0s 59ms/step - loss: 0.3725 - accuracy: 0.8694 - val_loss: 0.5599 - val_
accuracy: 0.737
5

Epoch 335/400
8/8 [==============================] - 0s 61ms/step - loss: 0.3918 - accuracy: 0.8347 - val_loss: 0.6440 - val_
accuracy: 0.662
5

Epoch 336/400
8/8 [==============================] - 1s 99ms/step - loss: 0.3784 - accuracy: 0.8431 - val_loss: 0.5508 - val_
accuracy: 0.762
5

Epoch 337/400
8/8 [==============================] - 1s 95ms/step - loss: 0.3893 - accuracy: 0.8375 - val_loss: 0.6501 - val_
accuracy: 0.675
0

Epoch 338/400
8/8 [==============================] - 0s 61ms/step - loss: 0.3808 - accuracy: 0.8500 - val_loss: 0.8455 - val_
accuracy: 0.575
0

Epoch 339/400
8/8 [==============================] - 0s 55ms/step - loss: 0.4122 - accuracy: 0.8181 - val_loss: 0.6523 - val_
accuracy: 0.687
5

Epoch 340/400
8/8 [==============================] - 0s 58ms/step - loss: 0.3824 - accuracy: 0.8542 - val_loss: 0.6271 - val_
accuracy: 0.687
5
 - ETA: 0s - loss: 0.4022 - accuracy: 0.835
0

Epoch 341/400
8/8 [==============================] - 0s 51ms/step - loss: 0.3788 - accuracy: 0.8556 - val_loss: 0.5796 - val_
accuracy: 0.662
5

Epoch 342/400
8/8 [==============================] - 0s 53ms/step - loss: 0.3781 - accuracy: 0.8625 - val_loss: 0.6003 - val_
accuracy: 0.675
0

Epoch 343/400
8/8 [==============================] - 0s 58ms/step - loss: 0.3703 - accuracy: 0.8389 - val_loss: 0.6402 - val_
accuracy: 0.687
5

Epoch 344/400
8/8 [==============================] - 0s 54ms/step - loss: 0.3849 - accuracy: 0.8458 - val_loss: 0.5836 - val_
accuracy: 0.662
5

Epoch 345/400
8/8 [==============================] - 0s 56ms/step - loss: 0.3702 - accuracy: 0.8472 - val_loss: 0.6043 - val_
accuracy: 0.687
5

Epoch 346/400
8/8 [==============================] - 1s 109ms/step - loss: 0.3732 - accuracy: 0.8611 - val_loss: 0.5504 - val
_accuracy: 0.737
5

Epoch 347/400
8/8 [==============================] - 1s 94ms/step - loss: 0.3640 - accuracy: 0.8569 - val_loss: 0.5664 - val_
accuracy: 0.750
0

Epoch 348/400
8/8 [==============================] - 1s 91ms/step - loss: 0.3728 - accuracy: 0.8542 - val_loss: 0.6521 - val_
accuracy: 0.675
0

Epoch 349/400
8/8 [==============================] - 0s 62ms/step - loss: 0.4267 - accuracy: 0.8056 - val_loss: 0.5507 - val_
accuracy: 0.750
0

Epoch 350/400
8/8 [==============================] - 1s 79ms/step - loss: 0.3676 - accuracy: 0.8611 - val_loss: 0.6348 - val_
accuracy: 0.650
0

Epoch 351/400
8/8 [==============================] - 1s 102ms/step - loss: 0.3780 - accuracy: 0.8611 - val_loss: 0.5871 - val
_accuracy: 0.700
0

Epoch 352/400
8/8 [==============================] - 1s 103ms/step - loss: 0.3740 - accuracy: 0.8389 - val_loss: 0.5922 - val
_accuracy: 0.700
0

Epoch 353/400
8/8 [==============================] - 1s 68ms/step - loss: 0.3632 - accuracy: 0.8639 - val_loss: 0.5667 - val_
accuracy: 0.700
0

Epoch 354/400
8/8 [==============================] - 1s 74ms/step - loss: 0.4168 - accuracy: 0.8000 - val_loss: 0.5723 - val_
accuracy: 0.675
0

Epoch 355/400
8/8 [==============================] - 1s 69ms/step - loss: 0.3626 - accuracy: 0.8653 - val_loss: 0.8175 - val_
accuracy: 0.612
5

Epoch 356/400
8/8 [==============================] - ETA: 0s - loss: 0.4141 - accuracy: 0.814
3
 - 0s 59ms/step - loss: 0.4119 - accuracy: 0.8167 - val_loss: 0.5932 - val_accuracy: 0.7250
Epoch 357/400
8/8 [==============================] - 0s 60ms/step - loss: 0.3795 - accuracy: 0.8500 - val_loss: 0.5520 - val_
accuracy: 0.675
0

Epoch 358/400
8/8 [==============================] - 1s 65ms/step - loss: 0.3576 - accuracy: 0.8736 - val_loss: 0.5663 - val_
accuracy: 0.737
5

Epoch 359/400
8/8 [==============================] - 0s 63ms/step - loss: 0.4494 - accuracy: 0.7958 - val_loss: 0.6080 - val_
accuracy: 0.675
0

Epoch 360/400
8/8 [==============================] - 1s 74ms/step - loss: 0.3895 - accuracy: 0.8389 - val_loss: 0.5840 - val_
accuracy: 0.712
5

Epoch 361/400
8/8 [==============================] - 1s 107ms/step - loss: 0.3700 - accuracy: 0.8625 - val_loss: 0.5987 - val
_accuracy: 0.675
0

Epoch 362/400
8/8 [==============================] - 1s 93ms/step - loss: 0.3771 - accuracy: 0.8444 - val_loss: 0.5629 - val_
accuracy: 0.712
5
 - ETA: 0s - loss: 0.3812 - accuracy: 0.841
Epoch 363/400
8/8 [==============================] - 1s 68ms/step - loss: 0.3763 - accuracy: 0.8306 - val_loss: 0.5833 - val_
accuracy: 0.712
5

Epoch 364/400
8/8 [==============================] - 0s 63ms/step - loss: 0.3935 - accuracy: 0.8403 - val_loss: 0.5771 - val_
accuracy: 0.687
5
 - ETA: 0s - loss: 0.3700 - accuracy: 0.856
7

Epoch 365/400
8/8 [==============================] - 1s 69ms/step - loss: 0.3670 - accuracy: 0.8611 - val_loss: 0.5588 - val_
accuracy: 0.712
5

Epoch 366/400
8/8 [==============================] - 1s 71ms/step - loss: 0.3721 - accuracy: 0.8375 - val_loss: 0.6737 - val_
accuracy: 0.675
0

Epoch 367/400
8/8 [==============================] - ETA: 0s - loss: 0.3873 - accuracy: 0.838
4
 - 0s 60ms/step - loss: 0.3917 - accuracy: 0.8347 - val_loss: 0.6515 - val_accuracy: 0.6750
Epoch 368/400
8/8 [==============================] - 0s 60ms/step - loss: 0.3820 - accuracy: 0.8514 - val_loss: 0.5855 - val_
accuracy: 0.700
0

Epoch 369/400
8/8 [==============================] - 1s 62ms/step - loss: 0.3630 - accuracy: 0.8500 - val_loss: 0.5434 - val_
accuracy: 0.775
0

Epoch 370/400
8/8 [==============================] - 0s 54ms/step - loss: 0.3544 - accuracy: 0.8653 - val_loss: 0.5477 - val_
accuracy: 0.725
0

Epoch 371/400
8/8 [==============================] - 0s 53ms/step - loss: 0.3818 - accuracy: 0.8306 - val_loss: 0.6657 - val_
accuracy: 0.675
0

Epoch 372/400
8/8 [==============================] - 0s 52ms/step - loss: 0.3727 - accuracy: 0.8597 - val_loss: 0.5631 - val_
accuracy: 0.787
```

```
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Epoch 373/400
8/8 [==============================] - 0s 57ms/step - loss: 0.3569 - accuracy: 0.8667 - val_loss: 0.5660 - val_
accuracy: 0.737
5□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 374/400
8/8 [==============================] - 1s 71ms/step - loss: 0.3490 - accuracy: 0.8722 - val_loss: 0.5662 - val_
accuracy: 0.737
5□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
 - ETA: 0s - loss: 0.3623 - accuracy: 0.860
0□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 375/400
8/8 [==============================] - 0s 57ms/step - loss: 0.3569 - accuracy: 0.8625 - val_loss: 0.5538 - val_
accuracy: 0.725
5□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 376/400
8/8 [==============================] - 0s 57ms/step - loss: 0.4019 - accuracy: 0.8125 - val_loss: 0.5613 - val_
accuracy: 0.762
5□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 377/400
8/8 [==============================] - 0s 56ms/step - loss: 0.3546 - accuracy: 0.8639 - val_loss: 0.5899 - val_
accuracy: 0.687
5□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 378/400
8/8 [==============================] - 0s 60ms/step - loss: 0.3652 - accuracy: 0.8417 - val_loss: 0.5762 - val_
accuracy: 0.700
0□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 379/400
8/8 [==============================] - 0s 56ms/step - loss: 0.3530 - accuracy: 0.8639 - val_loss: 0.5787 - val_
accuracy: 0.687
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Epoch 380/400
8/8 [==============================] - 0s 61ms/step - loss: 0.3608 - accuracy: 0.8569 - val_loss: 0.5473 - val_
accuracy: 0.762
3□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
 - ETA: 0s - loss: 0.3477 - accuracy: 0.868
0□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 381/400
8/8 [==============================] - 0s 54ms/step - loss: 0.3490 - accuracy: 0.8625 - val_loss: 0.6681 - val_
accuracy: 0.675
0□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 382/400
8/8 [==============================] - 0s 54ms/step - loss: 0.3789 - accuracy: 0.8431 - val_loss: 0.6251 - val_
accuracy: 0.662
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Epoch 383/400
8/8 [==============================] - 0s 55ms/step - loss: 0.3678 - accuracy: 0.8514 - val_loss: 0.5610 - val_
accuracy: 0.687
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Epoch 384/400
8/8 [==============================] - 1s 75ms/step - loss: 0.3880 - accuracy: 0.8722 - val_loss: 0.5584 - val_
accuracy: 0.750
0□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 385/400
8/8 [==============================] - 1s 60ms/step - loss: 0.3441 - accuracy: 0.8806 - val_loss: 0.5397 - val_
accuracy: 0.762
5□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 386/400
8/8 [==============================] - 1s 65ms/step - loss: 0.3452 - accuracy: 0.8764 - val_loss: 0.6201 - val_
accuracy: 0.662
0□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 387/400
8/8 [==============================] - 1s 78ms/step - loss: 0.3418 - accuracy: 0.8681 - val_loss: 0.5844 - val_
accuracy: 0.675
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Epoch 388/400
8/8 [==============================] - 1s 87ms/step - loss: 0.3651 - accuracy: 0.8472 - val_loss: 0.5516 - val_
accuracy: 0.737
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Epoch 389/400
8/8 [==============================] - 1s 65ms/step - loss: 0.3599 - accuracy: 0.8528 - val_loss: 0.6148 - val_
accuracy: 0.675
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Epoch 390/400
8/8 [==============================] - 0s 56ms/step - loss: 0.3606 - accuracy: 0.8542 - val_loss: 0.6980 - val_
accuracy: 0.625
0□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 391/400
8/8 [==============================] - 0s 54ms/step - loss: 0.3614 - accuracy: 0.8625 - val_loss: 0.5915 - val_
accuracy: 0.687
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Epoch 392/400
8/8 [==============================] - 0s 52ms/step - loss: 0.3376 - accuracy: 0.8667 - val_loss: 0.5606 - val_
accuracy: 0.700
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Epoch 393/400
8/8 [==============================] - 0s 56ms/step - loss: 0.3515 - accuracy: 0.8694 - val_loss: 0.5542 - val_
accuracy: 0.762
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Epoch 394/400
8/8 [==============================] - 0s 51ms/step - loss: 0.3841 - accuracy: 0.8236 - val_loss: 0.5825 - val_
accuracy: 0.700
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Epoch 395/400
8/8 [==============================] - 0s 56ms/step - loss: 0.3753 - accuracy: 0.8458 - val_loss: 0.5397 - val_
accuracy: 0.775
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Epoch 396/400
8/8 [==============================] - 0s 52ms/step - loss: 0.3359 - accuracy: 0.8722 - val_loss: 0.7050 - val_
accuracy: 0.687
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Epoch 397/400
8/8 [==============================] - 0s 55ms/step - loss: 0.3848 - accuracy: 0.8444 - val_loss: 0.6076 - val_
accuracy: 0.675
0□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

Epoch 398/400
8/8 [==============================] - 0s 60ms/step - loss: 0.3413 - accuracy: 0.8681 - val_loss: 0.5784 - val_
accuracy: 0.700
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Epoch 399/400
8/8 [==============================] - 0s 53ms/step - loss: 0.3272 - accuracy: 0.8847 - val_loss: 0.5859 - val_
accuracy: 0.700
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Epoch 400/400
8/8 [==============================] - 1s 139ms/step - loss: 0.3481 - accuracy: 0.8778 - val_loss: 0.5862 - val
_accuracy: 0.687
```
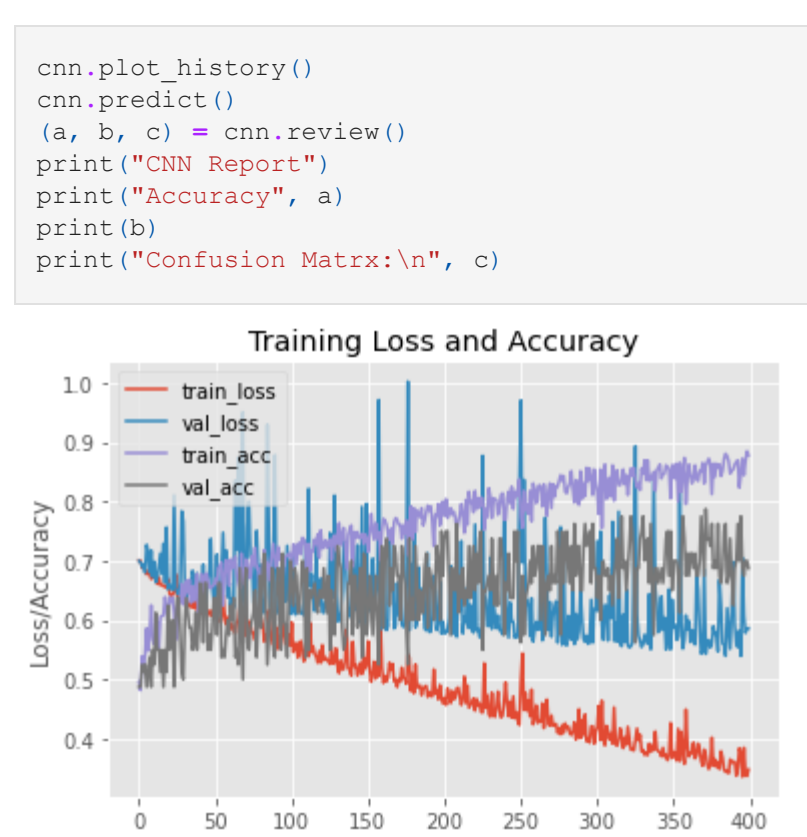

In [11]:

```
cnn.plot_history()
cnn.predict()
(a, b, c) = cnn.review()
print("CNN Report")
print("Accuracy", a)
print(b)
print("Confusion Matrix:\n", c)
```




```
CNN Report
Accuracy 0.6875
              precision    recall  f1-score   support

       brush       0.63      0.87      0.73        39
        comb       0.81      0.51      0.63        41

    accuracy                           0.69        80
   macro avg       0.72      0.69      0.68        80
weighted avg       0.72      0.69      0.68        80

Confusion Matrix:
 [[34  5]
 [20 21]]
```