MNIST Neural Shrub-Leaves

July 15, 2019

In [3]:
```
import time
import mnist
import numpy as np

from sklearn.tree import DecisionTreeClassifier

from sklearn.tree import export_graphviz
from sklearn.externals.six import StringIO
from IPython.display import Image
import pydotplus

from keras.utils import np_utils
from keras import Sequential
from keras import layers
```

In [4]:
```
# gets the data
def get_data():
    test = mnist.test_images()
    label_test = mnist.test_labels()
    train = mnist.train_images()
    label_train = mnist.train_labels()

    nsamples, nx, ny = train.shape
    train = train.reshape((nsamples,nx*ny))

    nsamples, nx, ny = test.shape
    test = test.reshape((nsamples,nx*ny))

    return train, label_train, test, label_test
```

In [5]:
```
from sklearn.tree._tree import TREE_LEAF

def prune_index(inner_tree, index, threshold):
    if inner_tree.value[index].min() < threshold:
        # turn node into a leaf by "unlinking" its children
        inner_tree.children_left[index] = TREE_LEAF
        inner_tree.children_right[index] = TREE_LEAF
```

```
        # if there are shildren, visit them as well
        if inner_tree.children_left[index] != TREE_LEAF:
            prune_index(inner_tree, inner_tree.children_left[index], threshold)
            prune_index(inner_tree, inner_tree.children_right[index], threshold)
```

In [6]:
```
# builds the decision tree of depth 10
def decision_tree(train, label):
    dt = DecisionTreeClassifier(max_depth = 10, random_state = 1)
    dt.fit(train, label)
    prune_index(dt.tree_, 0, 1)
    return dt
```

In [7]:
```
# building the neural network
def neural_network(class_data):
    num_train = []
    num_label = []
    for x in class_data:
        num_train.append(x[0])
        num_label.append(x[1])

    n_classes = 10
    num_train = np.matrix(num_train).astype('float32')/255
    num_label = np.array(num_label)
    num_label = np_utils.to_categorical(num_label, n_classes)

    model = Sequential()
    model.add(layers.Dense(512, activation = 'relu', input_shape=(784,)))
    model.add(layers.Dense(512, activation = 'relu'))
    model.add(layers.Dense(10, activation = 'softmax'))

    model.compile(loss='categorical_crossentropy', metrics=['accuracy'], \
                  optimizer='adam')
    model.fit(num_train, num_label, batch_size=128, epochs=10)
    return model
```

In [8]:
```
# builds the neural shrub
def neural_shrubs(tree, train, label):
    train = np.array(train)
    label = np.array(label)

    # leave_id: index of the leaf that cantains the instance
    leave_id = tree.apply(train)

    classes = dict()

    for x in range(len(train)):
        leaf = leave_id[x]
```

```
            # Gets the class for each leaf
            #.value: contains value of all the tree nodes
            #.value[leaf]: returns the value of the leaf
            #idx = tree.tree_.value[leaf][0][0]

            # insert the instance into the class
            if leaf in classes.keys():
                classes[leaf].append([train[x], label[x]])
            else:
                classes[leaf] = [[train[x], label[x]]]

        # stores the neural network for each class
        nn_models = dict()

        #stores the max time taken to build a neural network
        max_time = 0;

        for key in classes.keys():

            start = time.time()
            model = neural_network(classes[key])
            end = time.time()

            time_taken = end - start
            if max_time < time_taken:
                max_time = time_taken

            nn_models[key] = model

        # returns a neural network for each class and the max
        # time taken to build the neural network
        return nn_models, max_time
```

In [9]:
```
# The algorithm to build the neural shrub
train, train_label, test, test_label = get_data()

dt_start = time.time()

tree = decision_tree(train, train_label)
dot_data = StringIO()
export_graphviz(tree, out_file=dot_data)
graph = pydotplus.graph_from_dot_data(dot_data.getvalue())
Image(graph.create_png())

dt_end = time.time()
```

In [10]:
```
shrubs, max_time = neural_shrubs(tree, train, train_label)
```

```
Epoch 1/10
```

```
368/368 [==============================] - 0s 1ms/step - loss: 1.4510 - acc: 0.5761
Epoch 2/10
368/368 [==============================] - 0s 153us/step - loss: 0.6790 - acc: 0.8641
Epoch 3/10
368/368 [==============================] - 0s 157us/step - loss: 0.4023 - acc: 0.8750
Epoch 4/10
368/368 [==============================] - 0s 142us/step - loss: 0.2787 - acc: 0.9293
Epoch 5/10
368/368 [==============================] - 0s 138us/step - loss: 0.1959 - acc: 0.9538
Epoch 6/10
368/368 [==============================] - 0s 137us/step - loss: 0.1413 - acc: 0.9674
Epoch 7/10
368/368 [==============================] - 0s 145us/step - loss: 0.1117 - acc: 0.9728
Epoch 8/10
368/368 [==============================] - 0s 141us/step - loss: 0.0747 - acc: 0.9837
Epoch 9/10
368/368 [==============================] - 0s 158us/step - loss: 0.0548 - acc: 0.9891
Epoch 10/10
368/368 [==============================] - 0s 153us/step - loss: 0.0411 - acc: 0.9918
Epoch 1/10
476/476 [==============================] - 1s 1ms/step - loss: 1.8938 - acc: 0.3866
Epoch 2/10
476/476 [==============================] - 0s 140us/step - loss: 1.0196 - acc: 0.7269
Epoch 3/10
476/476 [==============================] - 0s 141us/step - loss: 0.5457 - acc: 0.8866
Epoch 4/10
476/476 [==============================] - 0s 167us/step - loss: 0.3128 - acc: 0.9139
Epoch 5/10
476/476 [==============================] - 0s 146us/step - loss: 0.2202 - acc: 0.9328
Epoch 6/10
476/476 [==============================] - 0s 152us/step - loss: 0.1370 - acc: 0.9601
Epoch 7/10
476/476 [==============================] - 0s 133us/step - loss: 0.1112 - acc: 0.9790
Epoch 8/10
476/476 [==============================] - 0s 146us/step - loss: 0.0658 - acc: 0.9853
Epoch 9/10
476/476 [==============================] - 0s 136us/step - loss: 0.0501 - acc: 0.9958
Epoch 10/10
476/476 [==============================] - 0s 134us/step - loss: 0.0400 - acc: 0.9937
Epoch 1/10
647/647 [==============================] - 0s 758us/step - loss: 1.3185 - acc: 0.5719
Epoch 2/10
647/647 [==============================] - 0s 143us/step - loss: 0.6710 - acc: 0.8346
Epoch 3/10
647/647 [==============================] - 0s 177us/step - loss: 0.4579 - acc: 0.8764
Epoch 4/10
647/647 [==============================] - 0s 145us/step - loss: 0.3780 - acc: 0.8841
Epoch 5/10
```

```
647/647 [==============================] - 0s 142us/step - loss: 0.2993 - acc: 0.9088
Epoch 6/10
647/647 [==============================] - 0s 131us/step - loss: 0.2565 - acc: 0.9274
Epoch 7/10
647/647 [==============================] - 0s 141us/step - loss: 0.2387 - acc: 0.9274
Epoch 8/10
647/647 [==============================] - 0s 138us/step - loss: 0.2096 - acc: 0.9351
Epoch 9/10
647/647 [==============================] - 0s 171us/step - loss: 0.1596 - acc: 0.9428
Epoch 10/10
647/647 [==============================] - 0s 144us/step - loss: 0.1188 - acc: 0.9691
Epoch 1/10
4796/4796 [==============================] - 1s 232us/step - loss: 0.3391 - acc: 0.9356
Epoch 2/10
4796/4796 [==============================] - 1s 152us/step - loss: 0.1285 - acc: 0.9652
Epoch 3/10
4796/4796 [==============================] - 1s 149us/step - loss: 0.0852 - acc: 0.9756
Epoch 4/10
4796/4796 [==============================] - 1s 136us/step - loss: 0.0538 - acc: 0.9833
Epoch 5/10
4796/4796 [==============================] - 1s 137us/step - loss: 0.0324 - acc: 0.9902
Epoch 6/10
4796/4796 [==============================] - 1s 142us/step - loss: 0.0214 - acc: 0.9929
Epoch 7/10
4796/4796 [==============================] - 1s 135us/step - loss: 0.0105 - acc: 0.9979
Epoch 8/10
4796/4796 [==============================] - 1s 143us/step - loss: 0.0075 - acc: 0.9985
Epoch 9/10
4796/4796 [==============================] - 1s 156us/step - loss: 0.0046 - acc: 0.9990
Epoch 10/10
4796/4796 [==============================] - 1s 142us/step - loss: 0.0021 - acc: 0.9998
Epoch 1/10
257/257 [==============================] - 1s 2ms/step - loss: 1.7586 - acc: 0.4786
Epoch 2/10
257/257 [==============================] - 0s 227us/step - loss: 0.3394 - acc: 0.9494
Epoch 3/10
257/257 [==============================] - 0s 256us/step - loss: 0.3887 - acc: 0.9494
Epoch 4/10
257/257 [==============================] - 0s 266us/step - loss: 0.2827 - acc: 0.9494
Epoch 5/10
257/257 [==============================] - 0s 262us/step - loss: 0.1417 - acc: 0.9494
Epoch 6/10
257/257 [==============================] - 0s 228us/step - loss: 0.1534 - acc: 0.9805
Epoch 7/10
257/257 [==============================] - 0s 275us/step - loss: 0.1338 - acc: 0.9805
Epoch 8/10
257/257 [==============================] - 0s 261us/step - loss: 0.0743 - acc: 0.9805
Epoch 9/10
```

```
257/257 [==============================] - 0s 257us/step - loss: 0.0634 - acc: 0.9805
Epoch 10/10
257/257 [==============================] - 0s 254us/step - loss: 0.0511 - acc: 0.9805
Epoch 1/10
227/227 [==============================] - 1s 2ms/step - loss: 2.0255 - acc: 0.3524
Epoch 2/10
227/227 [==============================] - 0s 214us/step - loss: 1.3540 - acc: 0.4802
Epoch 3/10
227/227 [==============================] - 0s 194us/step - loss: 1.0377 - acc: 0.7004
Epoch 4/10
227/227 [==============================] - 0s 230us/step - loss: 0.7529 - acc: 0.8018
Epoch 5/10
227/227 [==============================] - 0s 187us/step - loss: 0.5880 - acc: 0.8414
Epoch 6/10
227/227 [==============================] - 0s 189us/step - loss: 0.4371 - acc: 0.9119
Epoch 7/10
227/227 [==============================] - 0s 158us/step - loss: 0.3297 - acc: 0.9295
Epoch 8/10
227/227 [==============================] - 0s 189us/step - loss: 0.2513 - acc: 0.9295
Epoch 9/10
227/227 [==============================] - 0s 171us/step - loss: 0.1824 - acc: 0.9559
Epoch 10/10
227/227 [==============================] - 0s 205us/step - loss: 0.1366 - acc: 0.9868
Epoch 1/10
56/56 [==============================] - 0s 9ms/step - loss: 2.5381 - acc: 0.0000e+00
Epoch 2/10
56/56 [==============================] - 0s 292us/step - loss: 1.6616 - acc: 0.6250
Epoch 3/10
56/56 [==============================] - 0s 230us/step - loss: 1.2497 - acc: 0.6250
Epoch 4/10
56/56 [==============================] - 0s 345us/step - loss: 1.0361 - acc: 0.6429
Epoch 5/10
56/56 [==============================] - 0s 200us/step - loss: 0.8779 - acc: 0.7679
Epoch 6/10
56/56 [==============================] - 0s 379us/step - loss: 0.7611 - acc: 0.7857
Epoch 7/10
56/56 [==============================] - 0s 257us/step - loss: 0.6382 - acc: 0.8036
Epoch 8/10
56/56 [==============================] - 0s 290us/step - loss: 0.5035 - acc: 0.8214
Epoch 9/10
56/56 [==============================] - 0s 283us/step - loss: 0.3853 - acc: 0.8214
Epoch 10/10
56/56 [==============================] - 0s 297us/step - loss: 0.2829 - acc: 0.9107
Epoch 1/10
61/61 [==============================] - 1s 10ms/step - loss: 2.3552 - acc: 0.0656
Epoch 2/10
61/61 [==============================] - 0s 374us/step - loss: 1.7361 - acc: 0.6066
Epoch 3/10
```

```
61/61 [==============================] - 0s 250us/step - loss: 1.3013 - acc: 0.6066
Epoch 4/10
61/61 [==============================] - 0s 284us/step - loss: 1.0088 - acc: 0.6721
Epoch 5/10
61/61 [==============================] - 0s 249us/step - loss: 0.7792 - acc: 0.7869
Epoch 6/10
61/61 [==============================] - 0s 289us/step - loss: 0.5810 - acc: 0.8361
Epoch 7/10
61/61 [==============================] - 0s 269us/step - loss: 0.4317 - acc: 0.8852
Epoch 8/10
61/61 [==============================] - 0s 298us/step - loss: 0.3287 - acc: 0.9344
Epoch 9/10
61/61 [==============================] - 0s 247us/step - loss: 0.2537 - acc: 0.9508
Epoch 10/10
61/61 [==============================] - 0s 253us/step - loss: 0.1922 - acc: 0.9672
Epoch 1/10
662/662 [==============================] - 1s 931us/step - loss: 1.4203 - acc: 0.5045
Epoch 2/10
662/662 [==============================] - 0s 147us/step - loss: 0.6714 - acc: 0.8127
Epoch 3/10
662/662 [==============================] - 0s 163us/step - loss: 0.4196 - acc: 0.8761
Epoch 4/10
662/662 [==============================] - 0s 167us/step - loss: 0.3102 - acc: 0.9079
Epoch 5/10
662/662 [==============================] - 0s 158us/step - loss: 0.2249 - acc: 0.9290
Epoch 6/10
662/662 [==============================] - 0s 162us/step - loss: 0.1706 - acc: 0.9381
Epoch 7/10
662/662 [==============================] - 0s 153us/step - loss: 0.1077 - acc: 0.9728
Epoch 8/10
662/662 [==============================] - 0s 161us/step - loss: 0.0838 - acc: 0.9804
Epoch 9/10
662/662 [==============================] - 0s 174us/step - loss: 0.0651 - acc: 0.9819
Epoch 10/10
662/662 [==============================] - 0s 148us/step - loss: 0.0468 - acc: 0.9909
Epoch 1/10
148/148 [==============================] - 1s 4ms/step - loss: 2.1050 - acc: 0.2635
Epoch 2/10
148/148 [==============================] - 0s 236us/step - loss: 1.1436 - acc: 0.5811
Epoch 3/10
148/148 [==============================] - 0s 228us/step - loss: 0.8333 - acc: 0.7703
Epoch 4/10
148/148 [==============================] - 0s 254us/step - loss: 0.6596 - acc: 0.7770
Epoch 5/10
148/148 [==============================] - 0s 188us/step - loss: 0.4689 - acc: 0.8311
Epoch 6/10
148/148 [==============================] - 0s 286us/step - loss: 0.3739 - acc: 0.8649
Epoch 7/10
```

```
148/148 [==============================] - 0s 315us/step - loss: 0.3022 - acc: 0.9324
Epoch 8/10
148/148 [==============================] - 0s 304us/step - loss: 0.2270 - acc: 0.9662
Epoch 9/10
148/148 [==============================] - 0s 269us/step - loss: 0.1743 - acc: 0.9797
Epoch 10/10
148/148 [==============================] - 0s 226us/step - loss: 0.1249 - acc: 0.9797
Epoch 1/10
109/109 [==============================] - 1s 5ms/step - loss: 2.3367 - acc: 0.0275
Epoch 2/10
109/109 [==============================] - 0s 196us/step - loss: 1.7637 - acc: 0.5138
Epoch 3/10
109/109 [==============================] - 0s 153us/step - loss: 1.4511 - acc: 0.7064
Epoch 4/10
109/109 [==============================] - 0s 152us/step - loss: 1.2267 - acc: 0.7798
Epoch 5/10
109/109 [==============================] - 0s 163us/step - loss: 1.0243 - acc: 0.7798
Epoch 6/10
109/109 [==============================] - 0s 167us/step - loss: 0.8467 - acc: 0.8073
Epoch 7/10
109/109 [==============================] - 0s 194us/step - loss: 0.6822 - acc: 0.8257
Epoch 8/10
109/109 [==============================] - 0s 158us/step - loss: 0.5369 - acc: 0.8991
Epoch 9/10
109/109 [==============================] - 0s 212us/step - loss: 0.4205 - acc: 0.9541
Epoch 10/10
109/109 [==============================] - 0s 147us/step - loss: 0.3318 - acc: 0.9633
Epoch 1/10
89/89 [==============================] - 1s 7ms/step - loss: 2.1268 - acc: 0.4382
Epoch 2/10
89/89 [==============================] - 0s 227us/step - loss: 0.7909 - acc: 0.8764
Epoch 3/10
89/89 [==============================] - 0s 170us/step - loss: 0.4362 - acc: 0.8764
Epoch 4/10
89/89 [==============================] - 0s 320us/step - loss: 0.4464 - acc: 0.8764
Epoch 5/10
89/89 [==============================] - 0s 351us/step - loss: 0.4429 - acc: 0.8764
Epoch 6/10
89/89 [==============================] - 0s 227us/step - loss: 0.3913 - acc: 0.8764
Epoch 7/10
89/89 [==============================] - 0s 254us/step - loss: 0.3089 - acc: 0.8764
Epoch 8/10
89/89 [==============================] - 0s 206us/step - loss: 0.2207 - acc: 0.8876
Epoch 9/10
89/89 [==============================] - 0s 153us/step - loss: 0.1496 - acc: 0.9326
Epoch 10/10
89/89 [==============================] - 0s 164us/step - loss: 0.1067 - acc: 0.9663
Epoch 1/10
```

```
40/40 [==============================] - 1s 16ms/step - loss: 2.3347 - acc: 0.2000
Epoch 2/10
40/40 [==============================] - 0s 380us/step - loss: 1.6248 - acc: 0.3500
Epoch 3/10
40/40 [==============================] - 0s 423us/step - loss: 1.3032 - acc: 0.6250
Epoch 4/10
40/40 [==============================] - 0s 716us/step - loss: 1.1078 - acc: 0.7250
Epoch 5/10
40/40 [==============================] - 0s 494us/step - loss: 0.9339 - acc: 0.8000
Epoch 6/10
40/40 [==============================] - 0s 312us/step - loss: 0.7668 - acc: 0.8250
Epoch 7/10
40/40 [==============================] - 0s 376us/step - loss: 0.5887 - acc: 0.8500
Epoch 8/10
40/40 [==============================] - 0s 325us/step - loss: 0.4506 - acc: 0.9000
Epoch 9/10
40/40 [==============================] - 0s 360us/step - loss: 0.3529 - acc: 0.9500
Epoch 10/10
40/40 [==============================] - 0s 395us/step - loss: 0.2713 - acc: 0.9500
Epoch 1/10
194/194 [==============================] - 1s 3ms/step - loss: 1.9393 - acc: 0.2423
Epoch 2/10
194/194 [==============================] - 0s 183us/step - loss: 1.2073 - acc: 0.6959
Epoch 3/10
194/194 [==============================] - 0s 181us/step - loss: 0.9345 - acc: 0.7010
Epoch 4/10
194/194 [==============================] - 0s 170us/step - loss: 0.7614 - acc: 0.8247
Epoch 5/10
194/194 [==============================] - 0s 178us/step - loss: 0.5874 - acc: 0.8454
Epoch 6/10
194/194 [==============================] - 0s 224us/step - loss: 0.4639 - acc: 0.8299
Epoch 7/10
194/194 [==============================] - 0s 190us/step - loss: 0.3582 - acc: 0.8763
Epoch 8/10
194/194 [==============================] - 0s 204us/step - loss: 0.2713 - acc: 0.9381
Epoch 9/10
194/194 [==============================] - 0s 178us/step - loss: 0.2103 - acc: 0.9639
Epoch 10/10
194/194 [==============================] - 0s 185us/step - loss: 0.1586 - acc: 0.9691
Epoch 1/10
82/82 [==============================] - 1s 8ms/step - loss: 2.5909 - acc: 0.0000e+00
Epoch 2/10
82/82 [==============================] - 0s 223us/step - loss: 1.1171 - acc: 0.8902
Epoch 3/10
82/82 [==============================] - 0s 211us/step - loss: 0.5017 - acc: 0.8902
Epoch 4/10
82/82 [==============================] - 0s 263us/step - loss: 0.4581 - acc: 0.8902
Epoch 5/10
```

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82/82 [==============================] - 0s 168us/step - loss: 0.5031 - acc: 0.8902
Epoch 6/10
82/82 [==============================] - 0s 215us/step - loss: 0.5059 - acc: 0.8902
Epoch 7/10
82/82 [==============================] - 0s 301us/step - loss: 0.4611 - acc: 0.8902
Epoch 8/10
82/82 [==============================] - 0s 225us/step - loss: 0.3844 - acc: 0.8902
Epoch 9/10
82/82 [==============================] - 0s 201us/step - loss: 0.2931 - acc: 0.8902
Epoch 10/10
82/82 [==============================] - 0s 201us/step - loss: 0.2051 - acc: 0.9146
Epoch 1/10
737/737 [==============================] - 1s 1ms/step - loss: 1.2700 - acc: 0.6486
Epoch 2/10
737/737 [==============================] - 0s 142us/step - loss: 0.5802 - acc: 0.8412
Epoch 3/10
737/737 [==============================] - 0s 149us/step - loss: 0.3307 - acc: 0.8738
Epoch 4/10
737/737 [==============================] - 0s 171us/step - loss: 0.1936 - acc: 0.9579
Epoch 5/10
737/737 [==============================] - 0s 136us/step - loss: 0.1181 - acc: 0.9688
Epoch 6/10
737/737 [==============================] - 0s 149us/step - loss: 0.0764 - acc: 0.9837
Epoch 7/10
737/737 [==============================] - 0s 140us/step - loss: 0.0517 - acc: 0.9878
Epoch 8/10
737/737 [==============================] - 0s 142us/step - loss: 0.0364 - acc: 0.9905
Epoch 9/10
737/737 [==============================] - 0s 155us/step - loss: 0.0235 - acc: 0.9946
Epoch 10/10
737/737 [==============================] - 0s 138us/step - loss: 0.0159 - acc: 0.9973
Epoch 1/10
47/47 [==============================] - 1s 15ms/step - loss: 2.2668 - acc: 0.0638
Epoch 2/10
47/47 [==============================] - 0s 433us/step - loss: 1.6975 - acc: 0.4894
Epoch 3/10
47/47 [==============================] - 0s 276us/step - loss: 1.3445 - acc: 0.5319
Epoch 4/10
47/47 [==============================] - 0s 404us/step - loss: 1.1107 - acc: 0.6809
Epoch 5/10
47/47 [==============================] - 0s 334us/step - loss: 0.9022 - acc: 0.7234
Epoch 6/10
47/47 [==============================] - 0s 392us/step - loss: 0.7401 - acc: 0.8723
Epoch 7/10
47/47 [==============================] - 0s 283us/step - loss: 0.6224 - acc: 0.8723
Epoch 8/10
47/47 [==============================] - 0s 414us/step - loss: 0.5072 - acc: 0.8511
Epoch 9/10
```

```
47/47 [==============================] - 0s 307us/step - loss: 0.4055 - acc: 0.8723
Epoch 10/10
47/47 [==============================] - 0s 318us/step - loss: 0.3193 - acc: 0.8936
Epoch 1/10
197/197 [==============================] - 1s 4ms/step - loss: 2.0770 - acc: 0.2538
Epoch 2/10
197/197 [==============================] - 0s 198us/step - loss: 0.9584 - acc: 0.7411
Epoch 3/10
197/197 [==============================] - 0s 170us/step - loss: 0.8293 - acc: 0.7462
Epoch 4/10
197/197 [==============================] - 0s 224us/step - loss: 0.5976 - acc: 0.8274
Epoch 5/10
197/197 [==============================] - 0s 223us/step - loss: 0.5244 - acc: 0.8832
Epoch 6/10
197/197 [==============================] - 0s 215us/step - loss: 0.3846 - acc: 0.8832
Epoch 7/10
197/197 [==============================] - 0s 179us/step - loss: 0.2999 - acc: 0.8934
Epoch 8/10
197/197 [==============================] - 0s 190us/step - loss: 0.2479 - acc: 0.9340
Epoch 9/10
197/197 [==============================] - 0s 212us/step - loss: 0.1904 - acc: 0.9543
Epoch 10/10
197/197 [==============================] - 0s 209us/step - loss: 0.1467 - acc: 0.9746
Epoch 1/10
81/81 [==============================] - 1s 9ms/step - loss: 2.2588 - acc: 0.1235
Epoch 2/10
81/81 [==============================] - 0s 235us/step - loss: 1.5964 - acc: 0.5185
Epoch 3/10
81/81 [==============================] - 0s 213us/step - loss: 1.2727 - acc: 0.4938
Epoch 4/10
81/81 [==============================] - 0s 218us/step - loss: 1.1321 - acc: 0.6420
Epoch 5/10
81/81 [==============================] - 0s 176us/step - loss: 1.0271 - acc: 0.7654
Epoch 6/10
81/81 [==============================] - 0s 181us/step - loss: 0.8989 - acc: 0.7654
Epoch 7/10
81/81 [==============================] - 0s 203us/step - loss: 0.7412 - acc: 0.7654
Epoch 8/10
81/81 [==============================] - 0s 189us/step - loss: 0.6084 - acc: 0.7531
Epoch 9/10
81/81 [==============================] - 0s 274us/step - loss: 0.4949 - acc: 0.8642
Epoch 10/10
81/81 [==============================] - 0s 188us/step - loss: 0.4151 - acc: 0.9259
Epoch 1/10
200/200 [==============================] - 1s 4ms/step - loss: 1.8381 - acc: 0.3500
Epoch 2/10
200/200 [==============================] - 0s 260us/step - loss: 0.3038 - acc: 0.9500
Epoch 3/10
```

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200/200 [==============================] - 0s 143us/step - loss: 0.3859 - acc: 0.9500
Epoch 4/10
200/200 [==============================] - 0s 184us/step - loss: 0.3683 - acc: 0.9500
Epoch 5/10
200/200 [==============================] - 0s 193us/step - loss: 0.2959 - acc: 0.9500
Epoch 6/10
200/200 [==============================] - 0s 194us/step - loss: 0.2129 - acc: 0.9500
Epoch 7/10
200/200 [==============================] - 0s 189us/step - loss: 0.1420 - acc: 0.9550
Epoch 8/10
200/200 [==============================] - 0s 177us/step - loss: 0.1272 - acc: 0.9750
Epoch 9/10
200/200 [==============================] - 0s 198us/step - loss: 0.1123 - acc: 0.9750
Epoch 10/10
200/200 [==============================] - 0s 232us/step - loss: 0.0770 - acc: 0.9800
Epoch 1/10
344/344 [==============================] - 1s 2ms/step - loss: 1.3720 - acc: 0.5988
Epoch 2/10
344/344 [==============================] - 0s 175us/step - loss: 0.3293 - acc: 0.9477
Epoch 3/10
344/344 [==============================] - 0s 160us/step - loss: 0.3727 - acc: 0.9477
Epoch 4/10
344/344 [==============================] - 0s 145us/step - loss: 0.2956 - acc: 0.9477
Epoch 5/10
344/344 [==============================] - 0s 155us/step - loss: 0.1887 - acc: 0.9477
Epoch 6/10
344/344 [==============================] - 0s 140us/step - loss: 0.1276 - acc: 0.9680
Epoch 7/10
344/344 [==============================] - 0s 141us/step - loss: 0.1277 - acc: 0.9767
Epoch 8/10
344/344 [==============================] - 0s 143us/step - loss: 0.0866 - acc: 0.9738
Epoch 9/10
344/344 [==============================] - 0s 155us/step - loss: 0.0719 - acc: 0.9709
Epoch 10/10
344/344 [==============================] - 0s 150us/step - loss: 0.0560 - acc: 0.9738
Epoch 1/10
49/49 [==============================] - 1s 17ms/step - loss: 2.7883 - acc: 0.0204
Epoch 2/10
49/49 [==============================] - 0s 246us/step - loss: 1.0849 - acc: 0.9184
Epoch 3/10
49/49 [==============================] - 0s 362us/step - loss: 0.3450 - acc: 0.9184
Epoch 4/10
49/49 [==============================] - 0s 292us/step - loss: 0.2309 - acc: 0.9184
Epoch 5/10
49/49 [==============================] - 0s 381us/step - loss: 0.2270 - acc: 0.9184
Epoch 6/10
49/49 [==============================] - 0s 395us/step - loss: 0.2133 - acc: 0.9184
Epoch 7/10
```

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49/49 [==============================] - 0s 279us/step - loss: 0.1825 - acc: 0.9388
Epoch 8/10
49/49 [==============================] - 0s 340us/step - loss: 0.1423 - acc: 0.9592
Epoch 9/10
49/49 [==============================] - 0s 389us/step - loss: 0.1020 - acc: 0.9592
Epoch 10/10
49/49 [==============================] - 0s 263us/step - loss: 0.0672 - acc: 0.9592
Epoch 1/10
668/668 [==============================] - 1s 1ms/step - loss: 1.6978 - acc: 0.4296
Epoch 2/10
668/668 [==============================] - 0s 141us/step - loss: 0.8917 - acc: 0.7575
Epoch 3/10
668/668 [==============================] - 0s 170us/step - loss: 0.4869 - acc: 0.8847
Epoch 4/10
668/668 [==============================] - 0s 145us/step - loss: 0.2821 - acc: 0.9341
Epoch 5/10
668/668 [==============================] - 0s 158us/step - loss: 0.1673 - acc: 0.9551
Epoch 6/10
668/668 [==============================] - 0s 160us/step - loss: 0.1016 - acc: 0.9820
Epoch 7/10
668/668 [==============================] - 0s 146us/step - loss: 0.0740 - acc: 0.9850
Epoch 8/10
668/668 [==============================] - 0s 159us/step - loss: 0.0435 - acc: 0.9970
Epoch 9/10
668/668 [==============================] - 0s 149us/step - loss: 0.0290 - acc: 0.9985
Epoch 10/10
668/668 [==============================] - 0s 142us/step - loss: 0.0223 - acc: 0.9985
Epoch 1/10
5673/5673 [==============================] - 2s 287us/step - loss: 0.3425 - acc: 0.9327
Epoch 2/10
5673/5673 [==============================] - 1s 142us/step - loss: 0.0818 - acc: 0.9744
Epoch 3/10
5673/5673 [==============================] - 1s 133us/step - loss: 0.0435 - acc: 0.9873
Epoch 4/10
5673/5673 [==============================] - 1s 137us/step - loss: 0.0259 - acc: 0.9929
Epoch 5/10
5673/5673 [==============================] - 1s 136us/step - loss: 0.0157 - acc: 0.9959
Epoch 6/10
5673/5673 [==============================] - 1s 139us/step - loss: 0.0111 - acc: 0.9967
Epoch 7/10
5673/5673 [==============================] - 1s 138us/step - loss: 0.0067 - acc: 0.9981
Epoch 8/10
5673/5673 [==============================] - 1s 135us/step - loss: 0.0036 - acc: 0.9991
Epoch 9/10
5673/5673 [==============================] - 1s 136us/step - loss: 0.0034 - acc: 0.9991
Epoch 10/10
5673/5673 [==============================] - 1s 133us/step - loss: 0.0021 - acc: 0.9996
Epoch 1/10
```

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312/312 [==============================] - 1s 3ms/step - loss: 1.6816 - acc: 0.4615
Epoch 2/10
312/312 [==============================] - 0s 177us/step - loss: 0.9225 - acc: 0.7724
Epoch 3/10
312/312 [==============================] - 0s 161us/step - loss: 0.6982 - acc: 0.7821
Epoch 4/10
312/312 [==============================] - 0s 192us/step - loss: 0.5647 - acc: 0.8462
Epoch 5/10
312/312 [==============================] - 0s 183us/step - loss: 0.4347 - acc: 0.8494
Epoch 6/10
312/312 [==============================] - 0s 168us/step - loss: 0.3501 - acc: 0.8494
Epoch 7/10
312/312 [==============================] - 0s 180us/step - loss: 0.2771 - acc: 0.8974
Epoch 8/10
312/312 [==============================] - 0s 174us/step - loss: 0.2030 - acc: 0.9487
Epoch 9/10
312/312 [==============================] - 0s 136us/step - loss: 0.1554 - acc: 0.9647
Epoch 10/10
312/312 [==============================] - 0s 198us/step - loss: 0.1163 - acc: 0.9776
Epoch 1/10
975/975 [==============================] - 1s 1ms/step - loss: 0.6156 - acc: 0.8462
Epoch 2/10
975/975 [==============================] - 0s 146us/step - loss: 0.2324 - acc: 0.9631
Epoch 3/10
975/975 [==============================] - 0s 158us/step - loss: 0.1138 - acc: 0.9815
Epoch 4/10
975/975 [==============================] - 0s 145us/step - loss: 0.0694 - acc: 0.9815
Epoch 5/10
975/975 [==============================] - 0s 129us/step - loss: 0.0499 - acc: 0.9856
Epoch 6/10
975/975 [==============================] - 0s 151us/step - loss: 0.0354 - acc: 0.9867
Epoch 7/10
975/975 [==============================] - 0s 125us/step - loss: 0.0232 - acc: 0.9949
Epoch 8/10
975/975 [==============================] - 0s 137us/step - loss: 0.0164 - acc: 0.9959
Epoch 9/10
975/975 [==============================] - 0s 125us/step - loss: 0.0106 - acc: 0.9969
Epoch 10/10
975/975 [==============================] - 0s 150us/step - loss: 0.0061 - acc: 0.9990
Epoch 1/10
72/72 [==============================] - 1s 13ms/step - loss: 2.3173 - acc: 0.1111
Epoch 2/10
72/72 [==============================] - 0s 255us/step - loss: 1.7062 - acc: 0.4861
Epoch 3/10
72/72 [==============================] - 0s 246us/step - loss: 1.2921 - acc: 0.6944
Epoch 4/10
72/72 [==============================] - 0s 257us/step - loss: 0.9498 - acc: 0.9167
Epoch 5/10
```

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72/72 [==============================] - 0s 176us/step - loss: 0.6744 - acc: 0.9583
Epoch 6/10
72/72 [==============================] - 0s 273us/step - loss: 0.4617 - acc: 0.9444
Epoch 7/10
72/72 [==============================] - 0s 258us/step - loss: 0.3046 - acc: 0.9583
Epoch 8/10
72/72 [==============================] - 0s 250us/step - loss: 0.1920 - acc: 1.0000
Epoch 9/10
72/72 [==============================] - 0s 258us/step - loss: 0.1164 - acc: 1.0000
Epoch 10/10
72/72 [==============================] - 0s 257us/step - loss: 0.0729 - acc: 1.0000
Epoch 1/10
144/144 [==============================] - 1s 8ms/step - loss: 2.2942 - acc: 0.1181
Epoch 2/10
144/144 [==============================] - 0s 209us/step - loss: 1.5819 - acc: 0.5972
Epoch 3/10
144/144 [==============================] - 0s 244us/step - loss: 1.3280 - acc: 0.6042
Epoch 4/10
144/144 [==============================] - 0s 231us/step - loss: 1.1411 - acc: 0.6736
Epoch 5/10
144/144 [==============================] - 0s 237us/step - loss: 0.9980 - acc: 0.6597
Epoch 6/10
144/144 [==============================] - 0s 344us/step - loss: 0.9320 - acc: 0.7083
Epoch 7/10
144/144 [==============================] - 0s 274us/step - loss: 0.8327 - acc: 0.7569
Epoch 8/10
144/144 [==============================] - 0s 275us/step - loss: 0.7091 - acc: 0.7708
Epoch 9/10
144/144 [==============================] - 0s 244us/step - loss: 0.6178 - acc: 0.8125
Epoch 10/10
144/144 [==============================] - 0s 232us/step - loss: 0.5591 - acc: 0.8750
Epoch 1/10
31/31 [==============================] - 1s 31ms/step - loss: 2.3349 - acc: 0.1613
Epoch 2/10
31/31 [==============================] - 0s 608us/step - loss: 1.6155 - acc: 0.3548
Epoch 3/10
31/31 [==============================] - 0s 502us/step - loss: 1.2811 - acc: 0.4516
Epoch 4/10
31/31 [==============================] - 0s 705us/step - loss: 0.9636 - acc: 0.7742
Epoch 5/10
31/31 [==============================] - 0s 935us/step - loss: 0.7052 - acc: 0.8387
Epoch 6/10
31/31 [==============================] - 0s 645us/step - loss: 0.4979 - acc: 0.9032
Epoch 7/10
31/31 [==============================] - 0s 460us/step - loss: 0.3415 - acc: 1.0000
Epoch 8/10
31/31 [==============================] - 0s 397us/step - loss: 0.2314 - acc: 1.0000
Epoch 9/10
```

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31/31 [==============================] - 0s 455us/step - loss: 0.1519 - acc: 1.0000
Epoch 10/10
31/31 [==============================] - 0s 697us/step - loss: 0.0956 - acc: 1.0000
Epoch 1/10
8/8 [==============================] - 1s 124ms/step - loss: 2.3506 - acc: 0.1250
Epoch 2/10
8/8 [==============================] - 0s 2ms/step - loss: 1.2936 - acc: 0.7500
Epoch 3/10
8/8 [==============================] - 0s 2ms/step - loss: 0.7792 - acc: 0.7500
Epoch 4/10
8/8 [==============================] - 0s 2ms/step - loss: 0.4608 - acc: 0.8750
Epoch 5/10
8/8 [==============================] - 0s 2ms/step - loss: 0.2336 - acc: 1.0000
Epoch 6/10
8/8 [==============================] - 0s 2ms/step - loss: 0.1094 - acc: 1.0000
Epoch 7/10
8/8 [==============================] - 0s 2ms/step - loss: 0.0547 - acc: 1.0000
Epoch 8/10
8/8 [==============================] - 0s 2ms/step - loss: 0.0290 - acc: 1.0000
Epoch 9/10
8/8 [==============================] - 0s 2ms/step - loss: 0.0153 - acc: 1.0000
Epoch 10/10
8/8 [==============================] - 0s 2ms/step - loss: 0.0078 - acc: 1.0000
Epoch 1/10
100/100 [==============================] - 1s 10ms/step - loss: 2.0934 - acc: 0.3500
Epoch 2/10
100/100 [==============================] - 0s 230us/step - loss: 1.4232 - acc: 0.5800
Epoch 3/10
100/100 [==============================] - 0s 138us/step - loss: 1.2606 - acc: 0.5800
Epoch 4/10
100/100 [==============================] - 0s 183us/step - loss: 1.0665 - acc: 0.5800
Epoch 5/10
100/100 [==============================] - 0s 207us/step - loss: 0.8587 - acc: 0.6700
Epoch 6/10
100/100 [==============================] - 0s 217us/step - loss: 0.7532 - acc: 0.8100
Epoch 7/10
100/100 [==============================] - 0s 159us/step - loss: 0.6457 - acc: 0.8500
Epoch 8/10
100/100 [==============================] - 0s 178us/step - loss: 0.5036 - acc: 0.9200
Epoch 9/10
100/100 [==============================] - 0s 178us/step - loss: 0.3994 - acc: 0.9200
Epoch 10/10
100/100 [==============================] - 0s 187us/step - loss: 0.3417 - acc: 0.8900
Epoch 1/10
12/12 [==============================] - 1s 90ms/step - loss: 2.3160 - acc: 0.0833
Epoch 2/10
12/12 [==============================] - 0s 1ms/step - loss: 0.8524 - acc: 0.7500
Epoch 3/10
```

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12/12 [==============================] - 0s 1000us/step - loss: 0.6365 - acc: 0.7500
Epoch 4/10
12/12 [==============================] - 0s 996us/step - loss: 0.4015 - acc: 0.9167
Epoch 5/10
12/12 [==============================] - 0s 1ms/step - loss: 0.2794 - acc: 0.9167
Epoch 6/10
12/12 [==============================] - 0s 1ms/step - loss: 0.1946 - acc: 1.0000
Epoch 7/10
12/12 [==============================] - 0s 1ms/step - loss: 0.1166 - acc: 1.0000
Epoch 8/10
12/12 [==============================] - 0s 1ms/step - loss: 0.0751 - acc: 1.0000
Epoch 9/10
12/12 [==============================] - 0s 1ms/step - loss: 0.0499 - acc: 1.0000
Epoch 10/10
12/12 [==============================] - 0s 1ms/step - loss: 0.0396 - acc: 1.0000
Epoch 1/10
1290/1290 [==============================] - 1s 981us/step - loss: 1.0442 - acc: 0.7256
Epoch 2/10
1290/1290 [==============================] - 0s 142us/step - loss: 0.5027 - acc: 0.8403
Epoch 3/10
1290/1290 [==============================] - 0s 147us/step - loss: 0.3194 - acc: 0.9147
Epoch 4/10
1290/1290 [==============================] - 0s 160us/step - loss: 0.2116 - acc: 0.9349
Epoch 5/10
1290/1290 [==============================] - 0s 137us/step - loss: 0.1633 - acc: 0.9481
Epoch 6/10
1290/1290 [==============================] - 0s 144us/step - loss: 0.1289 - acc: 0.9643
Epoch 7/10
1290/1290 [==============================] - 0s 168us/step - loss: 0.0827 - acc: 0.9829
Epoch 8/10
1290/1290 [==============================] - 0s 139us/step - loss: 0.0561 - acc: 0.9884
Epoch 9/10
1290/1290 [==============================] - 0s 149us/step - loss: 0.0406 - acc: 0.9930
Epoch 10/10
1290/1290 [==============================] - 0s 141us/step - loss: 0.0274 - acc: 0.9938
Epoch 1/10
1282/1282 [==============================] - 1s 995us/step - loss: 1.3317 - acc: 0.5905
Epoch 2/10
1282/1282 [==============================] - 0s 145us/step - loss: 0.4474 - acc: 0.8729
Epoch 3/10
1282/1282 [==============================] - 0s 161us/step - loss: 0.2556 - acc: 0.9298
Epoch 4/10
1282/1282 [==============================] - 0s 149us/step - loss: 0.3297 - acc: 0.8885
Epoch 5/10
1282/1282 [==============================] - 0s 153us/step - loss: 0.1848 - acc: 0.9431
Epoch 6/10
1282/1282 [==============================] - 0s 148us/step - loss: 0.0955 - acc: 0.9743
Epoch 7/10
```

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1282/1282 [==============================] - 0s 141us/step - loss: 0.0674 - acc: 0.9836
Epoch 8/10
1282/1282 [==============================] - 0s 154us/step - loss: 0.0411 - acc: 0.9930
Epoch 9/10
1282/1282 [==============================] - 0s 141us/step - loss: 0.0256 - acc: 0.9977
Epoch 10/10
1282/1282 [==============================] - 0s 150us/step - loss: 0.0170 - acc: 0.9984
Epoch 1/10
64/64 [==============================] - 1s 17ms/step - loss: 2.2725 - acc: 0.1094
Epoch 2/10
64/64 [==============================] - 0s 251us/step - loss: 1.7075 - acc: 0.4375
Epoch 3/10
64/64 [==============================] - 0s 233us/step - loss: 1.4071 - acc: 0.5156
Epoch 4/10
64/64 [==============================] - 0s 277us/step - loss: 1.1934 - acc: 0.5469
Epoch 5/10
64/64 [==============================] - 0s 237us/step - loss: 0.9757 - acc: 0.6562
Epoch 6/10
64/64 [==============================] - 0s 279us/step - loss: 0.7787 - acc: 0.8125
Epoch 7/10
64/64 [==============================] - 0s 257us/step - loss: 0.6111 - acc: 0.8281
Epoch 8/10
64/64 [==============================] - 0s 265us/step - loss: 0.4719 - acc: 0.8906
Epoch 9/10
64/64 [==============================] - 0s 429us/step - loss: 0.3594 - acc: 0.9375
Epoch 10/10
64/64 [==============================] - 0s 294us/step - loss: 0.2677 - acc: 0.9844
Epoch 1/10
17/17 [==============================] - 1s 66ms/step - loss: 2.6514 - acc: 0.0000e+00
Epoch 2/10
17/17 [==============================] - 0s 993us/step - loss: 1.3517 - acc: 0.8235
Epoch 3/10
17/17 [==============================] - 0s 696us/step - loss: 0.7119 - acc: 0.8235
Epoch 4/10
17/17 [==============================] - 0s 948us/step - loss: 0.4711 - acc: 0.7647
Epoch 5/10
17/17 [==============================] - 0s 1ms/step - loss: 0.3088 - acc: 0.8235
Epoch 6/10
17/17 [==============================] - 0s 2ms/step - loss: 0.1657 - acc: 1.0000
Epoch 7/10
17/17 [==============================] - 0s 835us/step - loss: 0.1079 - acc: 1.0000
Epoch 8/10
17/17 [==============================] - 0s 753us/step - loss: 0.0888 - acc: 1.0000
Epoch 9/10
17/17 [==============================] - 0s 664us/step - loss: 0.0478 - acc: 1.0000
Epoch 10/10
17/17 [==============================] - 0s 1ms/step - loss: 0.0202 - acc: 1.0000
Epoch 1/10
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38/38 [==============================] - 1s 31ms/step - loss: 2.3912 - acc: 0.1316
Epoch 2/10
38/38 [==============================] - 0s 463us/step - loss: 1.3821 - acc: 0.6842
Epoch 3/10
38/38 [==============================] - 0s 401us/step - loss: 0.8684 - acc: 0.6842
Epoch 4/10
38/38 [==============================] - 0s 326us/step - loss: 0.7158 - acc: 0.6842
Epoch 5/10
38/38 [==============================] - 0s 518us/step - loss: 0.6077 - acc: 0.6842
Epoch 6/10
38/38 [==============================] - 0s 363us/step - loss: 0.4542 - acc: 0.7368
Epoch 7/10
38/38 [==============================] - 0s 447us/step - loss: 0.3300 - acc: 0.9737
Epoch 8/10
38/38 [==============================] - 0s 475us/step - loss: 0.2844 - acc: 0.9474
Epoch 9/10
38/38 [==============================] - 0s 434us/step - loss: 0.2496 - acc: 0.9474
Epoch 10/10
38/38 [==============================] - 0s 330us/step - loss: 0.1907 - acc: 0.9737
Epoch 1/10
50/50 [==============================] - 1s 24ms/step - loss: 2.1599 - acc: 0.2400
Epoch 2/10
50/50 [==============================] - 0s 344us/step - loss: 1.3579 - acc: 0.6800
Epoch 3/10
50/50 [==============================] - 0s 235us/step - loss: 1.0216 - acc: 0.6800
Epoch 4/10
50/50 [==============================] - 0s 328us/step - loss: 0.8650 - acc: 0.6800
Epoch 5/10
50/50 [==============================] - 0s 336us/step - loss: 0.6815 - acc: 0.7400
Epoch 6/10
50/50 [==============================] - 0s 401us/step - loss: 0.5331 - acc: 0.8200
Epoch 7/10
50/50 [==============================] - 0s 361us/step - loss: 0.4370 - acc: 0.8400
Epoch 8/10
50/50 [==============================] - 0s 380us/step - loss: 0.3443 - acc: 0.9400
Epoch 9/10
50/50 [==============================] - 0s 281us/step - loss: 0.2629 - acc: 0.9400
Epoch 10/10
50/50 [==============================] - 0s 301us/step - loss: 0.2058 - acc: 0.9200
Epoch 1/10
744/744 [==============================] - 1s 2ms/step - loss: 1.4661 - acc: 0.4933
Epoch 2/10
744/744 [==============================] - 0s 146us/step - loss: 0.7745 - acc: 0.7769
Epoch 3/10
744/744 [==============================] - 0s 148us/step - loss: 0.4680 - acc: 0.8629
Epoch 4/10
744/744 [==============================] - 0s 151us/step - loss: 0.3135 - acc: 0.9113
Epoch 5/10
```

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744/744 [==============================] - 0s 167us/step - loss: 0.2200 - acc: 0.9341
Epoch 6/10
744/744 [==============================] - 0s 141us/step - loss: 0.1488 - acc: 0.9651
Epoch 7/10
744/744 [==============================] - 0s 151us/step - loss: 0.0970 - acc: 0.9785
Epoch 8/10
744/744 [==============================] - 0s 136us/step - loss: 0.0644 - acc: 0.9866
Epoch 9/10
744/744 [==============================] - 0s 150us/step - loss: 0.0427 - acc: 0.9973
Epoch 10/10
744/744 [==============================] - 0s 167us/step - loss: 0.0270 - acc: 1.0000
Epoch 1/10
193/193 [==============================] - 1s 7ms/step - loss: 2.0469 - acc: 0.2383
Epoch 2/10
193/193 [==============================] - 0s 161us/step - loss: 0.9970 - acc: 0.6736
Epoch 3/10
193/193 [==============================] - 0s 197us/step - loss: 0.7489 - acc: 0.6995
Epoch 4/10
193/193 [==============================] - 0s 189us/step - loss: 0.4658 - acc: 0.8808
Epoch 5/10
193/193 [==============================] - 0s 185us/step - loss: 0.3840 - acc: 0.9585
Epoch 6/10
193/193 [==============================] - 0s 180us/step - loss: 0.2369 - acc: 0.9741
Epoch 7/10
193/193 [==============================] - 0s 244us/step - loss: 0.1602 - acc: 0.9689
Epoch 8/10
193/193 [==============================] - 0s 240us/step - loss: 0.1169 - acc: 0.9637
Epoch 9/10
193/193 [==============================] - 0s 186us/step - loss: 0.0767 - acc: 0.9793
Epoch 10/10
193/193 [==============================] - 0s 143us/step - loss: 0.0508 - acc: 0.9845
Epoch 1/10
410/410 [==============================] - 1s 3ms/step - loss: 1.7304 - acc: 0.4707
Epoch 2/10
410/410 [==============================] - 0s 142us/step - loss: 0.8549 - acc: 0.6976
Epoch 3/10
410/410 [==============================] - 0s 181us/step - loss: 0.5041 - acc: 0.8756
Epoch 4/10
410/410 [==============================] - 0s 141us/step - loss: 0.3231 - acc: 0.9049
Epoch 5/10
410/410 [==============================] - 0s 184us/step - loss: 0.2181 - acc: 0.9463
Epoch 6/10
410/410 [==============================] - 0s 147us/step - loss: 0.1515 - acc: 0.9659
Epoch 7/10
410/410 [==============================] - 0s 183us/step - loss: 0.1097 - acc: 0.9829
Epoch 8/10
410/410 [==============================] - 0s 208us/step - loss: 0.0815 - acc: 0.9854
Epoch 9/10
```

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410/410 [==============================] - 0s 166us/step - loss: 0.0586 - acc: 0.9902
Epoch 10/10
410/410 [==============================] - 0s 144us/step - loss: 0.0386 - acc: 0.9951
Epoch 1/10
392/392 [==============================] - 1s 3ms/step - loss: 1.8154 - acc: 0.4031
Epoch 2/10
392/392 [==============================] - 0s 168us/step - loss: 1.0345 - acc: 0.7066
Epoch 3/10
392/392 [==============================] - 0s 155us/step - loss: 0.6795 - acc: 0.8750
Epoch 4/10
392/392 [==============================] - 0s 183us/step - loss: 0.4776 - acc: 0.8750
Epoch 5/10
392/392 [==============================] - 0s 232us/step - loss: 0.3482 - acc: 0.8980
Epoch 6/10
392/392 [==============================] - 0s 177us/step - loss: 0.2588 - acc: 0.9209
Epoch 7/10
392/392 [==============================] - 0s 183us/step - loss: 0.2026 - acc: 0.9311
Epoch 8/10
392/392 [==============================] - 0s 150us/step - loss: 0.1960 - acc: 0.9286
Epoch 9/10
392/392 [==============================] - 0s 181us/step - loss: 0.1361 - acc: 0.9617
Epoch 10/10
392/392 [==============================] - 0s 145us/step - loss: 0.1147 - acc: 0.9643
Epoch 1/10
130/130 [==============================] - 1s 10ms/step - loss: 2.5741 - acc: 0.0077
Epoch 2/10
130/130 [==============================] - 0s 347us/step - loss: 0.8995 - acc: 0.8615
Epoch 3/10
130/130 [==============================] - 0s 279us/step - loss: 0.6378 - acc: 0.8615
Epoch 4/10
130/130 [==============================] - 0s 264us/step - loss: 0.7584 - acc: 0.8615
Epoch 5/10
130/130 [==============================] - 0s 276us/step - loss: 0.7422 - acc: 0.8615
Epoch 6/10
130/130 [==============================] - 0s 250us/step - loss: 0.6125 - acc: 0.8615
Epoch 7/10
130/130 [==============================] - 0s 230us/step - loss: 0.4462 - acc: 0.8615
Epoch 8/10
130/130 [==============================] - 0s 242us/step - loss: 0.3448 - acc: 0.8923
Epoch 9/10
130/130 [==============================] - 0s 308us/step - loss: 0.3154 - acc: 0.9154
Epoch 10/10
130/130 [==============================] - 0s 226us/step - loss: 0.2706 - acc: 0.9231
Epoch 1/10
490/490 [==============================] - 1s 3ms/step - loss: 1.0190 - acc: 0.6918
Epoch 2/10
490/490 [==============================] - 0s 166us/step - loss: 0.6009 - acc: 0.8837
Epoch 3/10
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490/490 [==============================] - 0s 134us/step - loss: 0.3877 - acc: 0.9000
Epoch 4/10
490/490 [==============================] - 0s 128us/step - loss: 0.2921 - acc: 0.9224
Epoch 5/10
490/490 [==============================] - 0s 148us/step - loss: 0.2202 - acc: 0.9163
Epoch 6/10
490/490 [==============================] - 0s 136us/step - loss: 0.1595 - acc: 0.9429
Epoch 7/10
490/490 [==============================] - 0s 137us/step - loss: 0.1205 - acc: 0.9653
Epoch 8/10
490/490 [==============================] - 0s 145us/step - loss: 0.0811 - acc: 0.9714
Epoch 9/10
490/490 [==============================] - 0s 188us/step - loss: 0.0589 - acc: 0.9776
Epoch 10/10
490/490 [==============================] - 0s 153us/step - loss: 0.0405 - acc: 0.9939
Epoch 1/10
310/310 [==============================] - 1s 5ms/step - loss: 1.4903 - acc: 0.5452
Epoch 2/10
310/310 [==============================] - 0s 173us/step - loss: 0.9016 - acc: 0.7903
Epoch 3/10
310/310 [==============================] - 0s 159us/step - loss: 0.6269 - acc: 0.8032
Epoch 4/10
310/310 [==============================] - 0s 149us/step - loss: 0.5160 - acc: 0.8871
Epoch 5/10
310/310 [==============================] - 0s 224us/step - loss: 0.3763 - acc: 0.9032
Epoch 6/10
310/310 [==============================] - 0s 170us/step - loss: 0.3113 - acc: 0.9065
Epoch 7/10
310/310 [==============================] - 0s 159us/step - loss: 0.2239 - acc: 0.9258
Epoch 8/10
310/310 [==============================] - 0s 192us/step - loss: 0.1798 - acc: 0.9548
Epoch 9/10
310/310 [==============================] - 0s 166us/step - loss: 0.1323 - acc: 0.9677
Epoch 10/10
310/310 [==============================] - 0s 169us/step - loss: 0.1070 - acc: 0.9677
Epoch 1/10
156/156 [==============================] - 2s 10ms/step - loss: 2.0928 - acc: 0.1731
Epoch 2/10
156/156 [==============================] - 0s 214us/step - loss: 1.0553 - acc: 0.6923
Epoch 3/10
156/156 [==============================] - 0s 234us/step - loss: 1.0342 - acc: 0.6923
Epoch 4/10
156/156 [==============================] - 0s 216us/step - loss: 0.8669 - acc: 0.6987
Epoch 5/10
156/156 [==============================] - 0s 202us/step - loss: 0.7535 - acc: 0.8269
Epoch 6/10
156/156 [==============================] - 0s 263us/step - loss: 0.6148 - acc: 0.8462
Epoch 7/10
```

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156/156 [==============================] - 0s 234us/step - loss: 0.5169 - acc: 0.8590
Epoch 8/10
156/156 [==============================] - 0s 221us/step - loss: 0.4403 - acc: 0.8718
Epoch 9/10
156/156 [==============================] - 0s 285us/step - loss: 0.3541 - acc: 0.9038
Epoch 10/10
156/156 [==============================] - 0s 323us/step - loss: 0.2650 - acc: 0.9359
Epoch 1/10
11/11 [==============================] - 1s 127ms/step - loss: 2.3997 - acc: 0.0000e+00
Epoch 2/10
11/11 [==============================] - 0s 2ms/step - loss: 0.4512 - acc: 1.0000
Epoch 3/10
11/11 [==============================] - 0s 1ms/step - loss: 0.0406 - acc: 1.0000
Epoch 4/10
11/11 [==============================] - 0s 2ms/step - loss: 0.0033 - acc: 1.0000
Epoch 5/10
11/11 [==============================] - 0s 1ms/step - loss: 2.9635e-04 - acc: 1.0000
Epoch 6/10
11/11 [==============================] - 0s 2ms/step - loss: 2.9240e-05 - acc: 1.0000
Epoch 7/10
11/11 [==============================] - 0s 1ms/step - loss: 3.2349e-06 - acc: 1.0000
Epoch 8/10
11/11 [==============================] - 0s 2ms/step - loss: 4.5516e-07 - acc: 1.0000
Epoch 9/10
11/11 [==============================] - 0s 1ms/step - loss: 1.4088e-07 - acc: 1.0000
Epoch 10/10
11/11 [==============================] - 0s 2ms/step - loss: 1.1921e-07 - acc: 1.0000
Epoch 1/10
203/203 [==============================] - 1s 7ms/step - loss: 1.8684 - acc: 0.3251
Epoch 2/10
203/203 [==============================] - 0s 168us/step - loss: 1.0966 - acc: 0.7438
Epoch 3/10
203/203 [==============================] - 0s 171us/step - loss: 0.9918 - acc: 0.7438
Epoch 4/10
203/203 [==============================] - 0s 194us/step - loss: 0.7547 - acc: 0.7586
Epoch 5/10
203/203 [==============================] - 0s 189us/step - loss: 0.7070 - acc: 0.8227
Epoch 6/10
203/203 [==============================] - 0s 224us/step - loss: 0.5635 - acc: 0.8374
Epoch 7/10
203/203 [==============================] - 0s 194us/step - loss: 0.4800 - acc: 0.8227
Epoch 8/10
203/203 [==============================] - 0s 193us/step - loss: 0.3993 - acc: 0.8325
Epoch 9/10
203/203 [==============================] - 0s 174us/step - loss: 0.2879 - acc: 0.9064
Epoch 10/10
203/203 [==============================] - 0s 170us/step - loss: 0.2526 - acc: 0.9557
Epoch 1/10
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251/251 [==============================] - 1s 6ms/step - loss: 1.5629 - acc: 0.5458
Epoch 2/10
251/251 [==============================] - 0s 144us/step - loss: 0.6084 - acc: 0.8845
Epoch 3/10
251/251 [==============================] - 0s 169us/step - loss: 0.6386 - acc: 0.8845
Epoch 4/10
251/251 [==============================] - 0s 142us/step - loss: 0.4678 - acc: 0.8845
Epoch 5/10
251/251 [==============================] - 0s 155us/step - loss: 0.3415 - acc: 0.9004
Epoch 6/10
251/251 [==============================] - 0s 189us/step - loss: 0.3571 - acc: 0.9243
Epoch 7/10
251/251 [==============================] - 0s 135us/step - loss: 0.2876 - acc: 0.9283
Epoch 8/10
251/251 [==============================] - 0s 197us/step - loss: 0.2296 - acc: 0.9243
Epoch 9/10
251/251 [==============================] - 0s 202us/step - loss: 0.2222 - acc: 0.9163
Epoch 10/10
251/251 [==============================] - 0s 165us/step - loss: 0.1912 - acc: 0.9243
Epoch 1/10
281/281 [==============================] - 2s 5ms/step - loss: 1.9697 - acc: 0.2918
Epoch 2/10
281/281 [==============================] - 0s 186us/step - loss: 0.9288 - acc: 0.7117
Epoch 3/10
281/281 [==============================] - 0s 196us/step - loss: 0.6901 - acc: 0.7936
Epoch 4/10
281/281 [==============================] - 0s 252us/step - loss: 0.4779 - acc: 0.8612
Epoch 5/10
281/281 [==============================] - 0s 204us/step - loss: 0.4093 - acc: 0.9181
Epoch 6/10
281/281 [==============================] - 0s 190us/step - loss: 0.2838 - acc: 0.9110
Epoch 7/10
281/281 [==============================] - 0s 192us/step - loss: 0.2046 - acc: 0.9288
Epoch 8/10
281/281 [==============================] - 0s 197us/step - loss: 0.1500 - acc: 0.9502
Epoch 9/10
281/281 [==============================] - 0s 182us/step - loss: 0.1106 - acc: 0.9680
Epoch 10/10
281/281 [==============================] - 0s 185us/step - loss: 0.0830 - acc: 0.9858
Epoch 1/10
66/66 [==============================] - 1s 23ms/step - loss: 2.1413 - acc: 0.3939
Epoch 2/10
66/66 [==============================] - 0s 306us/step - loss: 1.2406 - acc: 0.7424
Epoch 3/10
66/66 [==============================] - 0s 239us/step - loss: 0.9346 - acc: 0.7424
Epoch 4/10
66/66 [==============================] - 0s 290us/step - loss: 0.8468 - acc: 0.7424
Epoch 5/10
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66/66 [==============================] - 0s 292us/step - loss: 0.6822 - acc: 0.7424
Epoch 6/10
66/66 [==============================] - 0s 217us/step - loss: 0.4853 - acc: 0.7727
Epoch 7/10
66/66 [==============================] - 0s 243us/step - loss: 0.3649 - acc: 0.8788
Epoch 8/10
66/66 [==============================] - 0s 293us/step - loss: 0.3243 - acc: 0.9545
Epoch 9/10
66/66 [==============================] - 0s 347us/step - loss: 0.2806 - acc: 0.9545
Epoch 10/10
66/66 [==============================] - 0s 209us/step - loss: 0.2102 - acc: 0.9545
Epoch 1/10
88/88 [==============================] - 2s 17ms/step - loss: 2.3736 - acc: 0.0341
Epoch 2/10
88/88 [==============================] - 0s 231us/step - loss: 1.4661 - acc: 0.6705
Epoch 3/10
88/88 [==============================] - 0s 241us/step - loss: 1.0126 - acc: 0.6705
Epoch 4/10
88/88 [==============================] - 0s 221us/step - loss: 0.8432 - acc: 0.6705
Epoch 5/10
88/88 [==============================] - 0s 206us/step - loss: 0.6799 - acc: 0.7841
Epoch 6/10
88/88 [==============================] - 0s 220us/step - loss: 0.5435 - acc: 0.8523
Epoch 7/10
88/88 [==============================] - 0s 173us/step - loss: 0.4630 - acc: 0.8523
Epoch 8/10
88/88 [==============================] - 0s 179us/step - loss: 0.3919 - acc: 0.8636
Epoch 9/10
88/88 [==============================] - 0s 177us/step - loss: 0.3105 - acc: 0.9091
Epoch 10/10
88/88 [==============================] - 0s 253us/step - loss: 0.2402 - acc: 0.9545
Epoch 1/10
330/330 [==============================] - 2s 5ms/step - loss: 1.8313 - acc: 0.4030
Epoch 2/10
330/330 [==============================] - 0s 149us/step - loss: 1.1677 - acc: 0.6818
Epoch 3/10
330/330 [==============================] - 0s 169us/step - loss: 0.8724 - acc: 0.7485
Epoch 4/10
330/330 [==============================] - 0s 166us/step - loss: 0.6666 - acc: 0.7939
Epoch 5/10
330/330 [==============================] - 0s 187us/step - loss: 0.4970 - acc: 0.8364
Epoch 6/10
330/330 [==============================] - 0s 166us/step - loss: 0.3530 - acc: 0.9091
Epoch 7/10
330/330 [==============================] - 0s 163us/step - loss: 0.2595 - acc: 0.9485
Epoch 8/10
330/330 [==============================] - 0s 191us/step - loss: 0.1829 - acc: 0.9727
Epoch 9/10
```

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330/330 [==============================] - 0s 173us/step - loss: 0.1302 - acc: 0.9788
Epoch 10/10
330/330 [==============================] - 0s 170us/step - loss: 0.0975 - acc: 0.9879
Epoch 1/10
235/235 [==============================] - 2s 7ms/step - loss: 1.9114 - acc: 0.3872
Epoch 2/10
235/235 [==============================] - 0s 200us/step - loss: 0.8075 - acc: 0.8468
Epoch 3/10
235/235 [==============================] - 0s 136us/step - loss: 0.7801 - acc: 0.8468
Epoch 4/10
235/235 [==============================] - 0s 159us/step - loss: 0.5847 - acc: 0.8468
Epoch 5/10
235/235 [==============================] - 0s 147us/step - loss: 0.4563 - acc: 0.8809
Epoch 6/10
235/235 [==============================] - 0s 153us/step - loss: 0.4121 - acc: 0.8894
Epoch 7/10
235/235 [==============================] - 0s 180us/step - loss: 0.3189 - acc: 0.9064
Epoch 8/10
235/235 [==============================] - 0s 149us/step - loss: 0.2678 - acc: 0.8979
Epoch 9/10
235/235 [==============================] - 0s 168us/step - loss: 0.2092 - acc: 0.9106
Epoch 10/10
235/235 [==============================] - 0s 168us/step - loss: 0.1429 - acc: 0.9617
Epoch 1/10
644/644 [==============================] - 2s 3ms/step - loss: 1.5339 - acc: 0.5248
Epoch 2/10
644/644 [==============================] - 0s 157us/step - loss: 0.7331 - acc: 0.8571
Epoch 3/10
644/644 [==============================] - 0s 180us/step - loss: 0.4791 - acc: 0.8696
Epoch 4/10
644/644 [==============================] - 0s 151us/step - loss: 0.3318 - acc: 0.9146
Epoch 5/10
644/644 [==============================] - 0s 155us/step - loss: 0.2257 - acc: 0.9348
Epoch 6/10
644/644 [==============================] - 0s 157us/step - loss: 0.2405 - acc: 0.9193
Epoch 7/10
644/644 [==============================] - 0s 178us/step - loss: 0.2004 - acc: 0.9224
Epoch 8/10
644/644 [==============================] - 0s 174us/step - loss: 0.2527 - acc: 0.9270
Epoch 9/10
644/644 [==============================] - 0s 159us/step - loss: 0.1496 - acc: 0.9581
Epoch 10/10
644/644 [==============================] - 0s 164us/step - loss: 0.1240 - acc: 0.9565
Epoch 1/10
267/267 [==============================] - 2s 6ms/step - loss: 1.5554 - acc: 0.5243
Epoch 2/10
267/267 [==============================] - 0s 173us/step - loss: 0.7249 - acc: 0.7678
Epoch 3/10
```

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267/267 [==============================] - 0s 190us/step - loss: 0.4769 - acc: 0.8764
Epoch 4/10
267/267 [==============================] - 0s 204us/step - loss: 0.3166 - acc: 0.9064
Epoch 5/10
267/267 [==============================] - 0s 219us/step - loss: 0.2161 - acc: 0.9476
Epoch 6/10
267/267 [==============================] - 0s 198us/step - loss: 0.1904 - acc: 0.9551
Epoch 7/10
267/267 [==============================] - 0s 268us/step - loss: 0.1356 - acc: 0.9738
Epoch 8/10
267/267 [==============================] - 0s 195us/step - loss: 0.0970 - acc: 0.9700
Epoch 9/10
267/267 [==============================] - 0s 183us/step - loss: 0.0754 - acc: 0.9813
Epoch 10/10
267/267 [==============================] - 0s 221us/step - loss: 0.0548 - acc: 0.9888
Epoch 1/10
202/202 [==============================] - 2s 8ms/step - loss: 2.1385 - acc: 0.2574
Epoch 2/10
202/202 [==============================] - 0s 203us/step - loss: 1.1469 - acc: 0.7129
Epoch 3/10
202/202 [==============================] - 0s 190us/step - loss: 0.8511 - acc: 0.7624
Epoch 4/10
202/202 [==============================] - 0s 211us/step - loss: 0.6408 - acc: 0.8614
Epoch 5/10
202/202 [==============================] - 0s 185us/step - loss: 0.5186 - acc: 0.8911
Epoch 6/10
202/202 [==============================] - 0s 249us/step - loss: 0.3846 - acc: 0.8911
Epoch 7/10
202/202 [==============================] - 0s 161us/step - loss: 0.2839 - acc: 0.9010
Epoch 8/10
202/202 [==============================] - 0s 177us/step - loss: 0.2088 - acc: 0.9604
Epoch 9/10
202/202 [==============================] - 0s 154us/step - loss: 0.1725 - acc: 0.9752
Epoch 10/10
202/202 [==============================] - 0s 284us/step - loss: 0.1253 - acc: 0.9851
Epoch 1/10
3510/3510 [==============================] - 2s 692us/step - loss: 0.6633 - acc: 0.8103
Epoch 2/10
3510/3510 [==============================] - 0s 142us/step - loss: 0.2063 - acc: 0.9387
Epoch 3/10
3510/3510 [==============================] - 0s 140us/step - loss: 0.1159 - acc: 0.9687
Epoch 4/10
3510/3510 [==============================] - 0s 142us/step - loss: 0.0666 - acc: 0.9821
Epoch 5/10
3510/3510 [==============================] - 0s 141us/step - loss: 0.0405 - acc: 0.9886
Epoch 6/10
3510/3510 [==============================] - 0s 135us/step - loss: 0.0255 - acc: 0.9940
Epoch 7/10
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3510/3510 [==============================] - 0s 141us/step - loss: 0.0179 - acc: 0.9963
Epoch 8/10
3510/3510 [==============================] - 0s 138us/step - loss: 0.0112 - acc: 0.9980
Epoch 9/10
3510/3510 [==============================] - 0s 142us/step - loss: 0.0058 - acc: 0.9989
Epoch 10/10
3510/3510 [==============================] - 1s 145us/step - loss: 0.0040 - acc: 1.0000
Epoch 1/10
735/735 [==============================] - 2s 2ms/step - loss: 1.3165 - acc: 0.5469
Epoch 2/10
735/735 [==============================] - 0s 151us/step - loss: 0.5173 - acc: 0.8748
Epoch 3/10
735/735 [==============================] - 0s 149us/step - loss: 0.3761 - acc: 0.9211
Epoch 4/10
735/735 [==============================] - 0s 159us/step - loss: 0.2300 - acc: 0.9293
Epoch 5/10
735/735 [==============================] - 0s 141us/step - loss: 0.1760 - acc: 0.9592
Epoch 6/10
735/735 [==============================] - 0s 145us/step - loss: 0.1203 - acc: 0.9701
Epoch 7/10
735/735 [==============================] - 0s 156us/step - loss: 0.0833 - acc: 0.9769
Epoch 8/10
735/735 [==============================] - 0s 167us/step - loss: 0.0627 - acc: 0.9810
Epoch 9/10
735/735 [==============================] - 0s 143us/step - loss: 0.0410 - acc: 0.9891
Epoch 10/10
735/735 [==============================] - 0s 135us/step - loss: 0.0334 - acc: 0.9932
Epoch 1/10
246/246 [==============================] - 2s 7ms/step - loss: 2.0535 - acc: 0.3699
Epoch 2/10
246/246 [==============================] - 0s 168us/step - loss: 0.9042 - acc: 0.8130
Epoch 3/10
246/246 [==============================] - 0s 160us/step - loss: 0.5315 - acc: 0.8415
Epoch 4/10
246/246 [==============================] - 0s 184us/step - loss: 0.3839 - acc: 0.8780
Epoch 5/10
246/246 [==============================] - 0s 135us/step - loss: 0.2644 - acc: 0.9268
Epoch 6/10
246/246 [==============================] - 0s 232us/step - loss: 0.1998 - acc: 0.9472
Epoch 7/10
246/246 [==============================] - 0s 182us/step - loss: 0.1441 - acc: 0.9715
Epoch 8/10
246/246 [==============================] - 0s 136us/step - loss: 0.1168 - acc: 0.9715
Epoch 9/10
246/246 [==============================] - 0s 184us/step - loss: 0.0849 - acc: 0.9797
Epoch 10/10
246/246 [==============================] - 0s 132us/step - loss: 0.0536 - acc: 0.9919
Epoch 1/10
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392/392 [==============================] - 2s 5ms/step - loss: 1.4317 - acc: 0.5765
Epoch 2/10
392/392 [==============================] - 0s 160us/step - loss: 0.9581 - acc: 0.8291
Epoch 3/10
392/392 [==============================] - 0s 172us/step - loss: 0.6943 - acc: 0.8291
Epoch 4/10
392/392 [==============================] - 0s 173us/step - loss: 0.5293 - acc: 0.8342
Epoch 5/10
392/392 [==============================] - 0s 177us/step - loss: 0.4570 - acc: 0.8520
Epoch 6/10
392/392 [==============================] - 0s 184us/step - loss: 0.3692 - acc: 0.8648
Epoch 7/10
392/392 [==============================] - 0s 176us/step - loss: 0.3087 - acc: 0.8878
Epoch 8/10
392/392 [==============================] - 0s 178us/step - loss: 0.2345 - acc: 0.9133
Epoch 9/10
392/392 [==============================] - 0s 146us/step - loss: 0.1695 - acc: 0.9413
Epoch 10/10
392/392 [==============================] - 0s 182us/step - loss: 0.1286 - acc: 0.9592
Epoch 1/10
309/309 [==============================] - 2s 6ms/step - loss: 1.8987 - acc: 0.3172
Epoch 2/10
309/309 [==============================] - 0s 181us/step - loss: 0.8595 - acc: 0.7314
Epoch 3/10
309/309 [==============================] - 0s 205us/step - loss: 0.5262 - acc: 0.8673
Epoch 4/10
309/309 [==============================] - 0s 164us/step - loss: 0.4210 - acc: 0.8641
Epoch 5/10
309/309 [==============================] - 0s 155us/step - loss: 0.3085 - acc: 0.9126
Epoch 6/10
309/309 [==============================] - 0s 159us/step - loss: 0.2249 - acc: 0.9417
Epoch 7/10
309/309 [==============================] - 0s 152us/step - loss: 0.1759 - acc: 0.9482
Epoch 8/10
309/309 [==============================] - 0s 176us/step - loss: 0.1095 - acc: 0.9676
Epoch 9/10
309/309 [==============================] - 0s 161us/step - loss: 0.0815 - acc: 0.9871
Epoch 10/10
309/309 [==============================] - 0s 145us/step - loss: 0.0779 - acc: 0.9773
Epoch 1/10
2939/2939 [==============================] - 2s 747us/step - loss: 0.4452 - acc: 0.8918
Epoch 2/10
2939/2939 [==============================] - 0s 139us/step - loss: 0.1523 - acc: 0.9592
Epoch 3/10
2939/2939 [==============================] - 0s 145us/step - loss: 0.0955 - acc: 0.9721
Epoch 4/10
2939/2939 [==============================] - 0s 145us/step - loss: 0.0609 - acc: 0.9820
Epoch 5/10
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2939/2939 [==============================] - 0s 139us/step - loss: 0.0400 - acc: 0.9884
Epoch 6/10
2939/2939 [==============================] - 0s 137us/step - loss: 0.0209 - acc: 0.9942
Epoch 7/10
2939/2939 [==============================] - 0s 131us/step - loss: 0.0145 - acc: 0.9952
Epoch 8/10
2939/2939 [==============================] - 0s 138us/step - loss: 0.0073 - acc: 0.9986
Epoch 9/10
2939/2939 [==============================] - 0s 145us/step - loss: 0.0036 - acc: 1.0000
Epoch 10/10
2939/2939 [==============================] - 0s 140us/step - loss: 0.0023 - acc: 1.0000
Epoch 1/10
469/469 [==============================] - 2s 4ms/step - loss: 1.4140 - acc: 0.5565
Epoch 2/10
469/469 [==============================] - 0s 163us/step - loss: 0.8061 - acc: 0.7740
Epoch 3/10
469/469 [==============================] - 0s 154us/step - loss: 0.5231 - acc: 0.8380
Epoch 4/10
469/469 [==============================] - 0s 156us/step - loss: 0.4015 - acc: 0.8870
Epoch 5/10
469/469 [==============================] - 0s 174us/step - loss: 0.2843 - acc: 0.9211
Epoch 6/10
469/469 [==============================] - 0s 153us/step - loss: 0.2238 - acc: 0.9211
Epoch 7/10
469/469 [==============================] - 0s 139us/step - loss: 0.1674 - acc: 0.9595
Epoch 8/10
469/469 [==============================] - 0s 154us/step - loss: 0.1252 - acc: 0.9765
Epoch 9/10
469/469 [==============================] - 0s 148us/step - loss: 0.0897 - acc: 0.9829
Epoch 10/10
469/469 [==============================] - 0s 161us/step - loss: 0.0667 - acc: 0.9872
Epoch 1/10
669/669 [==============================] - 2s 3ms/step - loss: 0.7622 - acc: 0.7982
Epoch 2/10
669/669 [==============================] - 0s 152us/step - loss: 0.3952 - acc: 0.9522
Epoch 3/10
669/669 [==============================] - 0s 164us/step - loss: 0.2552 - acc: 0.9522
Epoch 4/10
669/669 [==============================] - 0s 158us/step - loss: 0.2365 - acc: 0.9522
Epoch 5/10
669/669 [==============================] - 0s 182us/step - loss: 0.1949 - acc: 0.9522
Epoch 6/10
669/669 [==============================] - 0s 157us/step - loss: 0.1630 - acc: 0.9522
Epoch 7/10
669/669 [==============================] - 0s 160us/step - loss: 0.1297 - acc: 0.9537
Epoch 8/10
669/669 [==============================] - 0s 161us/step - loss: 0.1052 - acc: 0.9567
Epoch 9/10
```

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669/669 [==============================] - 0s 154us/step - loss: 0.0786 - acc: 0.9686
Epoch 10/10
669/669 [==============================] - 0s 169us/step - loss: 0.0603 - acc: 0.9836
Epoch 1/10
212/212 [==============================] - 2s 9ms/step - loss: 2.1216 - acc: 0.2217
Epoch 2/10
212/212 [==============================] - 0s 184us/step - loss: 1.2086 - acc: 0.6038
Epoch 3/10
212/212 [==============================] - 0s 153us/step - loss: 1.0011 - acc: 0.7075
Epoch 4/10
212/212 [==============================] - 0s 197us/step - loss: 0.7979 - acc: 0.7689
Epoch 5/10
212/212 [==============================] - 0s 179us/step - loss: 0.6503 - acc: 0.8019
Epoch 6/10
212/212 [==============================] - 0s 212us/step - loss: 0.5113 - acc: 0.8726
Epoch 7/10
212/212 [==============================] - 0s 190us/step - loss: 0.4131 - acc: 0.9104
Epoch 8/10
212/212 [==============================] - 0s 234us/step - loss: 0.3290 - acc: 0.9387
Epoch 9/10
212/212 [==============================] - 0s 206us/step - loss: 0.2515 - acc: 0.9575
Epoch 10/10
212/212 [==============================] - 0s 174us/step - loss: 0.1952 - acc: 0.9623
Epoch 1/10
319/319 [==============================] - 2s 6ms/step - loss: 1.9303 - acc: 0.3166
Epoch 2/10
319/319 [==============================] - 0s 165us/step - loss: 1.0836 - acc: 0.6364
Epoch 3/10
319/319 [==============================] - 0s 197us/step - loss: 0.7601 - acc: 0.7900
Epoch 4/10
319/319 [==============================] - 0s 173us/step - loss: 0.5496 - acc: 0.8339
Epoch 5/10
319/319 [==============================] - 0s 241us/step - loss: 0.3948 - acc: 0.9185
Epoch 6/10
319/319 [==============================] - 0s 173us/step - loss: 0.3073 - acc: 0.9404
Epoch 7/10
319/319 [==============================] - 0s 163us/step - loss: 0.2317 - acc: 0.9467
Epoch 8/10
319/319 [==============================] - 0s 174us/step - loss: 0.1618 - acc: 0.9655
Epoch 9/10
319/319 [==============================] - 0s 197us/step - loss: 0.1204 - acc: 0.9781
Epoch 10/10
319/319 [==============================] - 0s 161us/step - loss: 0.0831 - acc: 0.9843
Epoch 1/10
952/952 [==============================] - 2s 2ms/step - loss: 1.0363 - acc: 0.7532
Epoch 2/10
952/952 [==============================] - 0s 143us/step - loss: 0.4162 - acc: 0.9086
Epoch 3/10
```

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952/952 [==============================] - 0s 163us/step - loss: 0.2787 - acc: 0.9097
Epoch 4/10
952/952 [==============================] - 0s 157us/step - loss: 0.1799 - acc: 0.9391
Epoch 5/10
952/952 [==============================] - 0s 143us/step - loss: 0.1146 - acc: 0.9664
Epoch 6/10
952/952 [==============================] - 0s 144us/step - loss: 0.0723 - acc: 0.9769
Epoch 7/10
952/952 [==============================] - 0s 165us/step - loss: 0.0440 - acc: 0.9905
Epoch 8/10
952/952 [==============================] - 0s 153us/step - loss: 0.0271 - acc: 0.9947
Epoch 9/10
952/952 [==============================] - 0s 155us/step - loss: 0.0166 - acc: 0.9968
Epoch 10/10
952/952 [==============================] - 0s 151us/step - loss: 0.0105 - acc: 1.0000
Epoch 1/10
149/149 [==============================] - 2s 13ms/step - loss: 2.2222 - acc: 0.1812
Epoch 2/10
149/149 [==============================] - 0s 209us/step - loss: 1.6288 - acc: 0.5570
Epoch 3/10
149/149 [==============================] - 0s 243us/step - loss: 1.2942 - acc: 0.7248
Epoch 4/10
149/149 [==============================] - 0s 222us/step - loss: 0.9957 - acc: 0.7517
Epoch 5/10
149/149 [==============================] - 0s 257us/step - loss: 0.7805 - acc: 0.8054
Epoch 6/10
149/149 [==============================] - 0s 257us/step - loss: 0.6315 - acc: 0.8523
Epoch 7/10
149/149 [==============================] - 0s 289us/step - loss: 0.4977 - acc: 0.8859
Epoch 8/10
149/149 [==============================] - 0s 220us/step - loss: 0.4000 - acc: 0.9060
Epoch 9/10
149/149 [==============================] - 0s 217us/step - loss: 0.3303 - acc: 0.9262
Epoch 10/10
149/149 [==============================] - 0s 300us/step - loss: 0.2515 - acc: 0.9530
Epoch 1/10
104/104 [==============================] - 2s 19ms/step - loss: 2.1610 - acc: 0.2981
Epoch 2/10
104/104 [==============================] - 0s 224us/step - loss: 1.6260 - acc: 0.4808
Epoch 3/10
104/104 [==============================] - 0s 175us/step - loss: 1.3996 - acc: 0.4808
Epoch 4/10
104/104 [==============================] - 0s 148us/step - loss: 1.1505 - acc: 0.6250
Epoch 5/10
104/104 [==============================] - 0s 167us/step - loss: 0.9868 - acc: 0.7500
Epoch 6/10
104/104 [==============================] - 0s 157us/step - loss: 0.8483 - acc: 0.7981
Epoch 7/10
```

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104/104 [==============================] - 0s 184us/step - loss: 0.6965 - acc: 0.8173
Epoch 8/10
104/104 [==============================] - 0s 202us/step - loss: 0.5775 - acc: 0.8269
Epoch 9/10
104/104 [==============================] - 0s 176us/step - loss: 0.4835 - acc: 0.8654
Epoch 10/10
104/104 [==============================] - 0s 195us/step - loss: 0.3888 - acc: 0.8846
Epoch 1/10
75/75 [==============================] - 2s 27ms/step - loss: 2.4344 - acc: 0.0800
Epoch 2/10
75/75 [==============================] - 0s 233us/step - loss: 1.3288 - acc: 0.7600
Epoch 3/10
75/75 [==============================] - 0s 228us/step - loss: 0.8772 - acc: 0.7600
Epoch 4/10
75/75 [==============================] - 0s 232us/step - loss: 0.8663 - acc: 0.7600
Epoch 5/10
75/75 [==============================] - 0s 221us/step - loss: 0.8499 - acc: 0.7600
Epoch 6/10
75/75 [==============================] - 0s 210us/step - loss: 0.7481 - acc: 0.7600
Epoch 7/10
75/75 [==============================] - 0s 194us/step - loss: 0.6317 - acc: 0.7600
Epoch 8/10
75/75 [==============================] - 0s 194us/step - loss: 0.6027 - acc: 0.8133
Epoch 9/10
75/75 [==============================] - 0s 203us/step - loss: 0.5883 - acc: 0.8667
Epoch 10/10
75/75 [==============================] - 0s 234us/step - loss: 0.5033 - acc: 0.8667
Epoch 1/10
66/66 [==============================] - 2s 31ms/step - loss: 2.3576 - acc: 0.0455
Epoch 2/10
66/66 [==============================] - 0s 309us/step - loss: 1.7433 - acc: 0.3939
Epoch 3/10
66/66 [==============================] - 0s 289us/step - loss: 1.3710 - acc: 0.4848
Epoch 4/10
66/66 [==============================] - 0s 223us/step - loss: 1.1394 - acc: 0.6970
Epoch 5/10
66/66 [==============================] - 0s 291us/step - loss: 0.9357 - acc: 0.7273
Epoch 6/10
66/66 [==============================] - 0s 286us/step - loss: 0.7623 - acc: 0.7424
Epoch 7/10
66/66 [==============================] - 0s 341us/step - loss: 0.6293 - acc: 0.8030
Epoch 8/10
66/66 [==============================] - 0s 231us/step - loss: 0.5125 - acc: 0.8182
Epoch 9/10
66/66 [==============================] - 0s 262us/step - loss: 0.4026 - acc: 0.8636
Epoch 10/10
66/66 [==============================] - 0s 224us/step - loss: 0.3096 - acc: 0.9242
Epoch 1/10
```

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200/200 [==============================] - 2s 12ms/step - loss: 2.1741 - acc: 0.2050
Epoch 2/10
200/200 [==============================] - 0s 168us/step - loss: 1.4617 - acc: 0.5750
Epoch 3/10
200/200 [==============================] - 0s 181us/step - loss: 1.0501 - acc: 0.6500
Epoch 4/10
200/200 [==============================] - 0s 208us/step - loss: 0.7625 - acc: 0.7550
Epoch 5/10
200/200 [==============================] - 0s 201us/step - loss: 0.5714 - acc: 0.8650
Epoch 6/10
200/200 [==============================] - 0s 205us/step - loss: 0.4613 - acc: 0.8950
Epoch 7/10
200/200 [==============================] - 0s 195us/step - loss: 0.3475 - acc: 0.9150
Epoch 8/10
200/200 [==============================] - 0s 200us/step - loss: 0.2649 - acc: 0.9200
Epoch 9/10
200/200 [==============================] - 0s 181us/step - loss: 0.1923 - acc: 0.9350
Epoch 10/10
200/200 [==============================] - 0s 176us/step - loss: 0.1370 - acc: 0.9750
Epoch 1/10
46/46 [==============================] - 2s 44ms/step - loss: 2.2836 - acc: 0.0000e+00
Epoch 2/10
46/46 [==============================] - 0s 420us/step - loss: 0.6635 - acc: 0.9783
Epoch 3/10
46/46 [==============================] - 0s 310us/step - loss: 0.1553 - acc: 0.9783
Epoch 4/10
46/46 [==============================] - 0s 389us/step - loss: 0.0919 - acc: 0.9783
Epoch 5/10
46/46 [==============================] - 0s 361us/step - loss: 0.0913 - acc: 0.9783
Epoch 6/10
46/46 [==============================] - 0s 430us/step - loss: 0.0880 - acc: 0.9783
Epoch 7/10
46/46 [==============================] - 0s 349us/step - loss: 0.0768 - acc: 0.9783
Epoch 8/10
46/46 [==============================] - 0s 336us/step - loss: 0.0578 - acc: 0.9783
Epoch 9/10
46/46 [==============================] - 0s 336us/step - loss: 0.0349 - acc: 0.9783
Epoch 10/10
46/46 [==============================] - 0s 403us/step - loss: 0.0151 - acc: 0.9783
Epoch 1/10
205/205 [==============================] - 2s 10ms/step - loss: 2.0717 - acc: 0.3512
Epoch 2/10
205/205 [==============================] - 0s 228us/step - loss: 0.5719 - acc: 0.8732
Epoch 3/10
205/205 [==============================] - 0s 179us/step - loss: 0.6129 - acc: 0.8732
Epoch 4/10
205/205 [==============================] - 0s 208us/step - loss: 0.5049 - acc: 0.8732
Epoch 5/10
```

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205/205 [==============================] - 0s 181us/step - loss: 0.3625 - acc: 0.9024
Epoch 6/10
205/205 [==============================] - 0s 181us/step - loss: 0.3665 - acc: 0.8976
Epoch 7/10
205/205 [==============================] - 0s 240us/step - loss: 0.2811 - acc: 0.9268
Epoch 8/10
205/205 [==============================] - 0s 247us/step - loss: 0.2304 - acc: 0.9366
Epoch 9/10
205/205 [==============================] - 0s 181us/step - loss: 0.2170 - acc: 0.9268
Epoch 10/10
205/205 [==============================] - 0s 187us/step - loss: 0.2020 - acc: 0.9415
Epoch 1/10
686/686 [==============================] - 2s 3ms/step - loss: 0.7122 - acc: 0.8047
Epoch 2/10
686/686 [==============================] - 0s 158us/step - loss: 0.3760 - acc: 0.9636
Epoch 3/10
686/686 [==============================] - 0s 156us/step - loss: 0.2786 - acc: 0.9636
Epoch 4/10
686/686 [==============================] - 0s 173us/step - loss: 0.1663 - acc: 0.9636
Epoch 5/10
686/686 [==============================] - 0s 169us/step - loss: 0.1620 - acc: 0.9665
Epoch 6/10
686/686 [==============================] - 0s 149us/step - loss: 0.1307 - acc: 0.9650
Epoch 7/10
686/686 [==============================] - 0s 146us/step - loss: 0.1153 - acc: 0.9665
Epoch 8/10
686/686 [==============================] - 0s 168us/step - loss: 0.0991 - acc: 0.9767
Epoch 9/10
686/686 [==============================] - 0s 180us/step - loss: 0.0766 - acc: 0.9810
Epoch 10/10
686/686 [==============================] - 0s 152us/step - loss: 0.0636 - acc: 0.9825
Epoch 1/10
648/648 [==============================] - 2s 3ms/step - loss: 1.6466 - acc: 0.4892
Epoch 2/10
648/648 [==============================] - 0s 167us/step - loss: 0.8351 - acc: 0.7377
Epoch 3/10
648/648 [==============================] - 0s 159us/step - loss: 0.4818 - acc: 0.8657
Epoch 4/10
648/648 [==============================] - 0s 160us/step - loss: 0.3066 - acc: 0.9213
Epoch 5/10
648/648 [==============================] - 0s 165us/step - loss: 0.2171 - acc: 0.9429
Epoch 6/10
648/648 [==============================] - 0s 149us/step - loss: 0.1547 - acc: 0.9630
Epoch 7/10
648/648 [==============================] - 0s 163us/step - loss: 0.1153 - acc: 0.9691
Epoch 8/10
648/648 [==============================] - 0s 172us/step - loss: 0.0929 - acc: 0.9738
Epoch 9/10
```

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648/648 [==============================] - 0s 212us/step - loss: 0.0926 - acc: 0.9722
Epoch 10/10
648/648 [==============================] - 0s 171us/step - loss: 0.0560 - acc: 0.9861
Epoch 1/10
33/33 [==============================] - 2s 66ms/step - loss: 2.2560 - acc: 0.0606
Epoch 2/10
33/33 [==============================] - 0s 532us/step - loss: 1.2144 - acc: 0.6970
Epoch 3/10
33/33 [==============================] - 0s 388us/step - loss: 0.8051 - acc: 0.6970
Epoch 4/10
33/33 [==============================] - 0s 445us/step - loss: 0.5871 - acc: 0.7879
Epoch 5/10
33/33 [==============================] - 0s 540us/step - loss: 0.4313 - acc: 0.9091
Epoch 6/10
33/33 [==============================] - 0s 551us/step - loss: 0.3594 - acc: 0.9091
Epoch 7/10
33/33 [==============================] - 0s 492us/step - loss: 0.2585 - acc: 0.9091
Epoch 8/10
33/33 [==============================] - 0s 596us/step - loss: 0.1507 - acc: 0.9091
Epoch 9/10
33/33 [==============================] - 0s 578us/step - loss: 0.0906 - acc: 1.0000
Epoch 10/10
33/33 [==============================] - 0s 530us/step - loss: 0.0756 - acc: 1.0000
Epoch 1/10
405/405 [==============================] - 2s 6ms/step - loss: 1.7179 - acc: 0.4469
Epoch 2/10
405/405 [==============================] - 0s 165us/step - loss: 0.9487 - acc: 0.6938
Epoch 3/10
405/405 [==============================] - 0s 182us/step - loss: 0.7103 - acc: 0.8395
Epoch 4/10
405/405 [==============================] - 0s 197us/step - loss: 0.5194 - acc: 0.8099
Epoch 5/10
405/405 [==============================] - 0s 189us/step - loss: 0.3679 - acc: 0.9037
Epoch 6/10
405/405 [==============================] - 0s 168us/step - loss: 0.2765 - acc: 0.9259
Epoch 7/10
405/405 [==============================] - 0s 165us/step - loss: 0.2058 - acc: 0.9481
Epoch 8/10
405/405 [==============================] - 0s 166us/step - loss: 0.1662 - acc: 0.9506
Epoch 9/10
405/405 [==============================] - 0s 152us/step - loss: 0.1250 - acc: 0.9605
Epoch 10/10
405/405 [==============================] - 0s 168us/step - loss: 0.0893 - acc: 0.9728
Epoch 1/10
234/234 [==============================] - 2s 10ms/step - loss: 1.9007 - acc: 0.3504
Epoch 2/10
234/234 [==============================] - 0s 219us/step - loss: 0.9915 - acc: 0.6197
Epoch 3/10
```

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234/234 [==============================] - 0s 179us/step - loss: 0.6598 - acc: 0.8590
Epoch 4/10
234/234 [==============================] - 0s 183us/step - loss: 0.5146 - acc: 0.8761
Epoch 5/10
234/234 [==============================] - 0s 178us/step - loss: 0.4198 - acc: 0.8846
Epoch 6/10
234/234 [==============================] - 0s 190us/step - loss: 0.3065 - acc: 0.9274
Epoch 7/10
234/234 [==============================] - 0s 177us/step - loss: 0.2351 - acc: 0.9359
Epoch 8/10
234/234 [==============================] - 0s 190us/step - loss: 0.1886 - acc: 0.9444
Epoch 9/10
234/234 [==============================] - 0s 157us/step - loss: 0.1504 - acc: 0.9701
Epoch 10/10
234/234 [==============================] - 0s 161us/step - loss: 0.1159 - acc: 0.9786
Epoch 1/10
107/107 [==============================] - 2s 21ms/step - loss: 2.2397 - acc: 0.1963
Epoch 2/10
107/107 [==============================] - 0s 193us/step - loss: 1.5702 - acc: 0.3925
Epoch 3/10
107/107 [==============================] - 0s 159us/step - loss: 1.2369 - acc: 0.6916
Epoch 4/10
107/107 [==============================] - 0s 148us/step - loss: 1.0067 - acc: 0.7290
Epoch 5/10
107/107 [==============================] - 0s 204us/step - loss: 0.8097 - acc: 0.8131
Epoch 6/10
107/107 [==============================] - 0s 230us/step - loss: 0.6504 - acc: 0.8598
Epoch 7/10
107/107 [==============================] - 0s 227us/step - loss: 0.5186 - acc: 0.8692
Epoch 8/10
107/107 [==============================] - 0s 258us/step - loss: 0.3929 - acc: 0.8692
Epoch 9/10
107/107 [==============================] - 0s 144us/step - loss: 0.2991 - acc: 0.9439
Epoch 10/10
107/107 [==============================] - 0s 185us/step - loss: 0.2350 - acc: 0.9626
Epoch 1/10
488/488 [==============================] - 2s 5ms/step - loss: 1.6502 - acc: 0.3852
Epoch 2/10
488/488 [==============================] - 0s 142us/step - loss: 0.9018 - acc: 0.7520
Epoch 3/10
488/488 [==============================] - 0s 155us/step - loss: 0.6137 - acc: 0.8422
Epoch 4/10
488/488 [==============================] - 0s 175us/step - loss: 0.4502 - acc: 0.8914
Epoch 5/10
488/488 [==============================] - 0s 144us/step - loss: 0.3364 - acc: 0.9016
Epoch 6/10
488/488 [==============================] - 0s 175us/step - loss: 0.2689 - acc: 0.9262
Epoch 7/10
```

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488/488 [==============================] - 0s 160us/step - loss: 0.2067 - acc: 0.9344
Epoch 8/10
488/488 [==============================] - 0s 141us/step - loss: 0.1692 - acc: 0.9508
Epoch 9/10
488/488 [==============================] - 0s 141us/step - loss: 0.1183 - acc: 0.9611
Epoch 10/10
488/488 [==============================] - 0s 139us/step - loss: 0.0926 - acc: 0.9734
Epoch 1/10
839/839 [==============================] - 2s 3ms/step - loss: 0.7515 - acc: 0.8224
Epoch 2/10
839/839 [==============================] - 0s 154us/step - loss: 0.3270 - acc: 0.9678
Epoch 3/10
839/839 [==============================] - 0s 151us/step - loss: 0.2124 - acc: 0.9678
Epoch 4/10
839/839 [==============================] - 0s 150us/step - loss: 0.1193 - acc: 0.9785
Epoch 5/10
839/839 [==============================] - 0s 171us/step - loss: 0.0913 - acc: 0.9797
Epoch 6/10
839/839 [==============================] - 0s 169us/step - loss: 0.0730 - acc: 0.9797
Epoch 7/10
839/839 [==============================] - 0s 157us/step - loss: 0.0566 - acc: 0.9857
Epoch 8/10
839/839 [==============================] - 0s 150us/step - loss: 0.0371 - acc: 0.9857
Epoch 9/10
839/839 [==============================] - 0s 168us/step - loss: 0.0286 - acc: 0.9905
Epoch 10/10
839/839 [==============================] - 0s 154us/step - loss: 0.0179 - acc: 0.9952
Epoch 1/10
464/464 [==============================] - 2s 5ms/step - loss: 1.5085 - acc: 0.5172
Epoch 2/10
464/464 [==============================] - 0s 143us/step - loss: 0.7260 - acc: 0.8168
Epoch 3/10
464/464 [==============================] - 0s 183us/step - loss: 0.4940 - acc: 0.8728
Epoch 4/10
464/464 [==============================] - 0s 155us/step - loss: 0.3629 - acc: 0.8836
Epoch 5/10
464/464 [==============================] - 0s 164us/step - loss: 0.2446 - acc: 0.9289
Epoch 6/10
464/464 [==============================] - 0s 151us/step - loss: 0.1828 - acc: 0.9483
Epoch 7/10
464/464 [==============================] - 0s 152us/step - loss: 0.1267 - acc: 0.9612
Epoch 8/10
464/464 [==============================] - 0s 179us/step - loss: 0.0844 - acc: 0.9806
Epoch 9/10
464/464 [==============================] - 0s 161us/step - loss: 0.0534 - acc: 0.9935
Epoch 10/10
464/464 [==============================] - 0s 208us/step - loss: 0.0359 - acc: 0.9978
Epoch 1/10
```

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164/164 [==============================] - 2s 15ms/step - loss: 2.1310 - acc: 0.3171
Epoch 2/10
164/164 [==============================] - 0s 245us/step - loss: 0.8619 - acc: 0.7744
Epoch 3/10
164/164 [==============================] - 0s 224us/step - loss: 0.7185 - acc: 0.8659
Epoch 4/10
164/164 [==============================] - 0s 218us/step - loss: 0.6220 - acc: 0.8659
Epoch 5/10
164/164 [==============================] - 0s 257us/step - loss: 0.4348 - acc: 0.8841
Epoch 6/10
164/164 [==============================] - 0s 245us/step - loss: 0.2948 - acc: 0.9085
Epoch 7/10
164/164 [==============================] - 0s 232us/step - loss: 0.2372 - acc: 0.9573
Epoch 8/10
164/164 [==============================] - 0s 252us/step - loss: 0.1860 - acc: 0.9695
Epoch 9/10
164/164 [==============================] - 0s 203us/step - loss: 0.1433 - acc: 0.9756
Epoch 10/10
164/164 [==============================] - 0s 239us/step - loss: 0.1131 - acc: 0.9756
Epoch 1/10
66/66 [==============================] - 2s 36ms/step - loss: 2.3501 - acc: 0.0606
Epoch 2/10
66/66 [==============================] - 0s 290us/step - loss: 1.4976 - acc: 0.5303
Epoch 3/10
66/66 [==============================] - 0s 209us/step - loss: 1.2163 - acc: 0.5303
Epoch 4/10
66/66 [==============================] - 0s 262us/step - loss: 1.0607 - acc: 0.6818
Epoch 5/10
66/66 [==============================] - 0s 341us/step - loss: 0.9282 - acc: 0.7424
Epoch 6/10
66/66 [==============================] - 0s 251us/step - loss: 0.8112 - acc: 0.7424
Epoch 7/10
66/66 [==============================] - 0s 247us/step - loss: 0.6683 - acc: 0.7424
Epoch 8/10
66/66 [==============================] - 0s 209us/step - loss: 0.5472 - acc: 0.8182
Epoch 9/10
66/66 [==============================] - 0s 288us/step - loss: 0.4550 - acc: 0.9242
Epoch 10/10
66/66 [==============================] - 0s 242us/step - loss: 0.3717 - acc: 0.9394
Epoch 1/10
292/292 [==============================] - 2s 9ms/step - loss: 1.7328 - acc: 0.4349
Epoch 2/10
292/292 [==============================] - 0s 166us/step - loss: 0.9376 - acc: 0.7568
Epoch 3/10
292/292 [==============================] - 0s 168us/step - loss: 0.5929 - acc: 0.8116
Epoch 4/10
292/292 [==============================] - 0s 185us/step - loss: 0.4635 - acc: 0.8527
Epoch 5/10
```

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292/292 [==============================] - 0s 206us/step - loss: 0.3213 - acc: 0.8870
Epoch 6/10
292/292 [==============================] - 0s 198us/step - loss: 0.2397 - acc: 0.9212
Epoch 7/10
292/292 [==============================] - 0s 239us/step - loss: 0.1712 - acc: 0.9726
Epoch 8/10
292/292 [==============================] - 0s 174us/step - loss: 0.1335 - acc: 0.9760
Epoch 9/10
292/292 [==============================] - 0s 209us/step - loss: 0.0908 - acc: 0.9795
Epoch 10/10
292/292 [==============================] - 0s 167us/step - loss: 0.0742 - acc: 0.9863
Epoch 1/10
468/468 [==============================] - 3s 5ms/step - loss: 1.5377 - acc: 0.4423
Epoch 2/10
468/468 [==============================] - 0s 188us/step - loss: 0.6448 - acc: 0.8226
Epoch 3/10
468/468 [==============================] - 0s 158us/step - loss: 0.4360 - acc: 0.9167
Epoch 4/10
468/468 [==============================] - 0s 167us/step - loss: 0.2846 - acc: 0.9359
Epoch 5/10
468/468 [==============================] - 0s 151us/step - loss: 0.2052 - acc: 0.9551
Epoch 6/10
468/468 [==============================] - 0s 139us/step - loss: 0.1381 - acc: 0.9722
Epoch 7/10
468/468 [==============================] - 0s 150us/step - loss: 0.1010 - acc: 0.9722
Epoch 8/10
468/468 [==============================] - 0s 209us/step - loss: 0.0616 - acc: 0.9893
Epoch 9/10
468/468 [==============================] - 0s 158us/step - loss: 0.0414 - acc: 0.9957
Epoch 10/10
468/468 [==============================] - 0s 168us/step - loss: 0.0282 - acc: 0.9979
Epoch 1/10
3014/3014 [==============================] - 3s 967us/step - loss: 0.3576 - acc: 0.9200
Epoch 2/10
3014/3014 [==============================] - 0s 149us/step - loss: 0.1114 - acc: 0.9685
Epoch 3/10
3014/3014 [==============================] - 0s 141us/step - loss: 0.0616 - acc: 0.9841
Epoch 4/10
3014/3014 [==============================] - 0s 151us/step - loss: 0.0397 - acc: 0.9887
Epoch 5/10
3014/3014 [==============================] - 0s 144us/step - loss: 0.0277 - acc: 0.9907
Epoch 6/10
3014/3014 [==============================] - 0s 152us/step - loss: 0.0176 - acc: 0.9947
Epoch 7/10
3014/3014 [==============================] - 0s 147us/step - loss: 0.0119 - acc: 0.9967
Epoch 8/10
3014/3014 [==============================] - 0s 147us/step - loss: 0.0078 - acc: 0.9977
Epoch 9/10
```

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3014/3014 [==============================] - 0s 151us/step - loss: 0.0060 - acc: 0.9987
Epoch 10/10
3014/3014 [==============================] - 0s 147us/step - loss: 0.0055 - acc: 0.9993
Epoch 1/10
686/686 [==============================] - 3s 4ms/step - loss: 1.4130 - acc: 0.6647
Epoch 2/10
686/686 [==============================] - 0s 155us/step - loss: 0.4328 - acc: 0.9023
Epoch 3/10
686/686 [==============================] - 0s 175us/step - loss: 0.2547 - acc: 0.9271
Epoch 4/10
686/686 [==============================] - 0s 172us/step - loss: 0.1891 - acc: 0.9475
Epoch 5/10
686/686 [==============================] - 0s 164us/step - loss: 0.1262 - acc: 0.9548
Epoch 6/10
686/686 [==============================] - 0s 169us/step - loss: 0.0856 - acc: 0.9752
Epoch 7/10
686/686 [==============================] - 0s 165us/step - loss: 0.0684 - acc: 0.9854
Epoch 8/10
686/686 [==============================] - 0s 188us/step - loss: 0.0445 - acc: 0.9869
Epoch 9/10
686/686 [==============================] - 0s 156us/step - loss: 0.0272 - acc: 0.9956
Epoch 10/10
686/686 [==============================] - 0s 143us/step - loss: 0.0195 - acc: 0.9971
Epoch 1/10
110/110 [==============================] - 3s 23ms/step - loss: 2.0457 - acc: 0.5000
Epoch 2/10
110/110 [==============================] - 0s 285us/step - loss: 0.9427 - acc: 0.8091
Epoch 3/10
110/110 [==============================] - 0s 186us/step - loss: 0.7579 - acc: 0.8091
Epoch 4/10
110/110 [==============================] - 0s 172us/step - loss: 0.7460 - acc: 0.8091
Epoch 5/10
110/110 [==============================] - 0s 196us/step - loss: 0.6304 - acc: 0.8091
Epoch 6/10
110/110 [==============================] - 0s 170us/step - loss: 0.4874 - acc: 0.8636
Epoch 7/10
110/110 [==============================] - 0s 199us/step - loss: 0.4286 - acc: 0.8909
Epoch 8/10
110/110 [==============================] - 0s 187us/step - loss: 0.4040 - acc: 0.9182
Epoch 9/10
110/110 [==============================] - 0s 195us/step - loss: 0.3202 - acc: 0.9455
Epoch 10/10
110/110 [==============================] - 0s 182us/step - loss: 0.2554 - acc: 0.9364
Epoch 1/10
33/33 [==============================] - 3s 78ms/step - loss: 2.3493 - acc: 0.0000e+00
Epoch 2/10
33/33 [==============================] - 0s 640us/step - loss: 1.5535 - acc: 0.6970
Epoch 3/10
```

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33/33 [==============================] - 0s 573us/step - loss: 1.0754 - acc: 0.7273
Epoch 4/10
33/33 [==============================] - 0s 508us/step - loss: 0.7821 - acc: 0.8182
Epoch 5/10
33/33 [==============================] - 0s 476us/step - loss: 0.5681 - acc: 0.8485
Epoch 6/10
33/33 [==============================] - 0s 432us/step - loss: 0.4064 - acc: 0.9394
Epoch 7/10
33/33 [==============================] - 0s 569us/step - loss: 0.2940 - acc: 0.9394
Epoch 8/10
33/33 [==============================] - 0s 437us/step - loss: 0.2049 - acc: 0.9394
Epoch 9/10
33/33 [==============================] - 0s 513us/step - loss: 0.1317 - acc: 0.9697
Epoch 10/10
33/33 [==============================] - 0s 425us/step - loss: 0.0826 - acc: 0.9697
Epoch 1/10
172/172 [==============================] - 3s 15ms/step - loss: 2.2592 - acc: 0.2093
Epoch 2/10
172/172 [==============================] - 0s 190us/step - loss: 0.7054 - acc: 0.8663
Epoch 3/10
172/172 [==============================] - 0s 276us/step - loss: 0.5882 - acc: 0.8663
Epoch 4/10
172/172 [==============================] - 0s 244us/step - loss: 0.3963 - acc: 0.8895
Epoch 5/10
172/172 [==============================] - 0s 225us/step - loss: 0.3535 - acc: 0.9360
Epoch 6/10
172/172 [==============================] - 0s 211us/step - loss: 0.2580 - acc: 0.9360
Epoch 7/10
172/172 [==============================] - 0s 237us/step - loss: 0.1917 - acc: 0.9477
Epoch 8/10
172/172 [==============================] - 0s 239us/step - loss: 0.1689 - acc: 0.9535
Epoch 9/10
172/172 [==============================] - 0s 202us/step - loss: 0.1528 - acc: 0.9477
Epoch 10/10
172/172 [==============================] - 0s 206us/step - loss: 0.1242 - acc: 0.9477
Epoch 1/10
133/133 [==============================] - 3s 20ms/step - loss: 2.3672 - acc: 0.0526
Epoch 2/10
133/133 [==============================] - 0s 272us/step - loss: 1.2906 - acc: 0.5113
Epoch 3/10
133/133 [==============================] - 0s 274us/step - loss: 1.1078 - acc: 0.6466
Epoch 4/10
133/133 [==============================] - 0s 283us/step - loss: 0.9558 - acc: 0.7744
Epoch 5/10
133/133 [==============================] - 0s 349us/step - loss: 0.7774 - acc: 0.7895
Epoch 6/10
133/133 [==============================] - 0s 292us/step - loss: 0.5920 - acc: 0.8496
Epoch 7/10
```

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133/133 [==============================] - 0s 293us/step - loss: 0.5135 - acc: 0.8872
Epoch 8/10
133/133 [==============================] - 0s 331us/step - loss: 0.4644 - acc: 0.8797
Epoch 9/10
133/133 [==============================] - 0s 283us/step - loss: 0.3709 - acc: 0.8947
Epoch 10/10
133/133 [==============================] - 0s 277us/step - loss: 0.2689 - acc: 0.9248
Epoch 1/10
3833/3833 [==============================] - 3s 824us/step - loss: 0.2479 - acc: 0.9468
Epoch 2/10
3833/3833 [==============================] - 1s 143us/step - loss: 0.0747 - acc: 0.9812
Epoch 3/10
3833/3833 [==============================] - 1s 142us/step - loss: 0.0496 - acc: 0.9870
Epoch 4/10
3833/3833 [==============================] - 1s 138us/step - loss: 0.0301 - acc: 0.9903
Epoch 5/10
3833/3833 [==============================] - 1s 147us/step - loss: 0.0152 - acc: 0.9950
Epoch 6/10
3833/3833 [==============================] - 1s 146us/step - loss: 0.0070 - acc: 0.9984
Epoch 7/10
3833/3833 [==============================] - 1s 149us/step - loss: 0.0035 - acc: 0.9995
Epoch 8/10
3833/3833 [==============================] - 1s 148us/step - loss: 0.0019 - acc: 1.0000
Epoch 9/10
3833/3833 [==============================] - 1s 142us/step - loss: 9.9854e-04 - acc: 1.0000
Epoch 10/10
3833/3833 [==============================] - 1s 145us/step - loss: 5.4329e-04 - acc: 1.0000
Epoch 1/10
77/77 [==============================] - 3s 35ms/step - loss: 2.3000 - acc: 0.1948
Epoch 2/10
77/77 [==============================] - 0s 256us/step - loss: 1.5688 - acc: 0.5584
Epoch 3/10
77/77 [==============================] - 0s 238us/step - loss: 1.2091 - acc: 0.5455
Epoch 4/10
77/77 [==============================] - 0s 211us/step - loss: 0.9279 - acc: 0.7403
Epoch 5/10
77/77 [==============================] - 0s 245us/step - loss: 0.7172 - acc: 0.8831
Epoch 6/10
77/77 [==============================] - 0s 218us/step - loss: 0.5511 - acc: 0.9221
Epoch 7/10
77/77 [==============================] - 0s 199us/step - loss: 0.4169 - acc: 0.8961
Epoch 8/10
77/77 [==============================] - 0s 232us/step - loss: 0.3219 - acc: 0.8961
Epoch 9/10
77/77 [==============================] - 0s 244us/step - loss: 0.2449 - acc: 0.9481
Epoch 10/10
77/77 [==============================] - 0s 231us/step - loss: 0.1858 - acc: 0.9870
Epoch 1/10
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55/55 [==============================] - 3s 49ms/step - loss: 2.6888 - acc: 0.0000e+00
Epoch 2/10
55/55 [==============================] - 0s 290us/step - loss: 0.9920 - acc: 0.8727
Epoch 3/10
55/55 [==============================] - 0s 355us/step - loss: 0.5090 - acc: 0.8727
Epoch 4/10
55/55 [==============================] - 0s 291us/step - loss: 0.4228 - acc: 0.8727
Epoch 5/10
55/55 [==============================] - 0s 314us/step - loss: 0.3120 - acc: 0.8727
Epoch 6/10
55/55 [==============================] - 0s 348us/step - loss: 0.1950 - acc: 0.9455
Epoch 7/10
55/55 [==============================] - 0s 317us/step - loss: 0.1440 - acc: 0.9636
Epoch 8/10
55/55 [==============================] - 0s 421us/step - loss: 0.1327 - acc: 0.9636
Epoch 9/10
55/55 [==============================] - 0s 352us/step - loss: 0.1279 - acc: 0.9636
Epoch 10/10
55/55 [==============================] - 0s 318us/step - loss: 0.0983 - acc: 0.9636
Epoch 1/10
24/24 [==============================] - 3s 111ms/step - loss: 2.3758 - acc: 0.0000e+00
Epoch 2/10
24/24 [==============================] - 0s 804us/step - loss: 1.0373 - acc: 0.8750
Epoch 3/10
24/24 [==============================] - 0s 600us/step - loss: 0.4707 - acc: 0.8750
Epoch 4/10
24/24 [==============================] - 0s 734us/step - loss: 0.3969 - acc: 0.8750
Epoch 5/10
24/24 [==============================] - 0s 564us/step - loss: 0.3877 - acc: 0.8750
Epoch 6/10
24/24 [==============================] - 0s 707us/step - loss: 0.3405 - acc: 0.8750
Epoch 7/10
24/24 [==============================] - 0s 658us/step - loss: 0.2623 - acc: 0.8750
Epoch 8/10
24/24 [==============================] - 0s 773us/step - loss: 0.1791 - acc: 0.9167
Epoch 9/10
24/24 [==============================] - 0s 838us/step - loss: 0.1087 - acc: 0.9167
Epoch 10/10
24/24 [==============================] - 0s 715us/step - loss: 0.0594 - acc: 1.0000
Epoch 1/10
592/592 [==============================] - 3s 5ms/step - loss: 1.1749 - acc: 0.6926
Epoch 2/10
592/592 [==============================] - 0s 160us/step - loss: 0.5825 - acc: 0.8885
Epoch 3/10
592/592 [==============================] - 0s 169us/step - loss: 0.3955 - acc: 0.9071
Epoch 4/10
592/592 [==============================] - 0s 144us/step - loss: 0.3018 - acc: 0.9071
Epoch 5/10
```

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592/592 [==============================] - 0s 167us/step - loss: 0.2266 - acc: 0.9358
Epoch 6/10
592/592 [==============================] - 0s 179us/step - loss: 0.1847 - acc: 0.9375
Epoch 7/10
592/592 [==============================] - 0s 179us/step - loss: 0.1412 - acc: 0.9527
Epoch 8/10
592/592 [==============================] - 0s 171us/step - loss: 0.1116 - acc: 0.9679
Epoch 9/10
592/592 [==============================] - 0s 169us/step - loss: 0.0847 - acc: 0.9797
Epoch 10/10
592/592 [==============================] - 0s 173us/step - loss: 0.0640 - acc: 0.9831
Epoch 1/10
363/363 [==============================] - 3s 8ms/step - loss: 1.8738 - acc: 0.3003
Epoch 2/10
363/363 [==============================] - 0s 177us/step - loss: 1.0388 - acc: 0.6694
Epoch 3/10
363/363 [==============================] - 0s 171us/step - loss: 0.6819 - acc: 0.8237
Epoch 4/10
363/363 [==============================] - 0s 171us/step - loss: 0.4790 - acc: 0.8871
Epoch 5/10
363/363 [==============================] - 0s 162us/step - loss: 0.3266 - acc: 0.9063
Epoch 6/10
363/363 [==============================] - 0s 174us/step - loss: 0.2367 - acc: 0.9366
Epoch 7/10
363/363 [==============================] - 0s 170us/step - loss: 0.1641 - acc: 0.9559
Epoch 8/10
363/363 [==============================] - 0s 174us/step - loss: 0.1137 - acc: 0.9614
Epoch 9/10
363/363 [==============================] - 0s 209us/step - loss: 0.0662 - acc: 0.9890
Epoch 10/10
363/363 [==============================] - 0s 161us/step - loss: 0.0378 - acc: 0.9972
Epoch 1/10
222/222 [==============================] - 3s 13ms/step - loss: 2.0017 - acc: 0.2117
Epoch 2/10
222/222 [==============================] - 0s 177us/step - loss: 0.9964 - acc: 0.5811
Epoch 3/10
222/222 [==============================] - 0s 208us/step - loss: 0.7287 - acc: 0.8063
Epoch 4/10
222/222 [==============================] - 0s 170us/step - loss: 0.5790 - acc: 0.8919
Epoch 5/10
222/222 [==============================] - 0s 174us/step - loss: 0.4792 - acc: 0.9009
Epoch 6/10
222/222 [==============================] - 0s 171us/step - loss: 0.3757 - acc: 0.9189
Epoch 7/10
222/222 [==============================] - 0s 175us/step - loss: 0.2940 - acc: 0.9144
Epoch 8/10
222/222 [==============================] - 0s 261us/step - loss: 0.2146 - acc: 0.9234
Epoch 9/10
```

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222/222 [==============================] - 0s 197us/step - loss: 0.1652 - acc: 0.9550
Epoch 10/10
222/222 [==============================] - 0s 207us/step - loss: 0.1185 - acc: 0.9775
Epoch 1/10
148/148 [==============================] - 3s 19ms/step - loss: 2.2626 - acc: 0.1419
Epoch 2/10
148/148 [==============================] - 0s 231us/step - loss: 1.5058 - acc: 0.5946
Epoch 3/10
148/148 [==============================] - 0s 235us/step - loss: 1.1356 - acc: 0.6757
Epoch 4/10
148/148 [==============================] - 0s 269us/step - loss: 0.8350 - acc: 0.7838
Epoch 5/10
148/148 [==============================] - 0s 244us/step - loss: 0.6409 - acc: 0.8581
Epoch 6/10
148/148 [==============================] - 0s 259us/step - loss: 0.5097 - acc: 0.8649
Epoch 7/10
148/148 [==============================] - 0s 253us/step - loss: 0.3850 - acc: 0.8784
Epoch 8/10
148/148 [==============================] - 0s 265us/step - loss: 0.2852 - acc: 0.9257
Epoch 9/10
148/148 [==============================] - 0s 342us/step - loss: 0.2508 - acc: 0.9324
Epoch 10/10
148/148 [==============================] - 0s 270us/step - loss: 0.1909 - acc: 0.9527
Epoch 1/10
31/31 [==============================] - 3s 91ms/step - loss: 2.3930 - acc: 0.0000e+00
Epoch 2/10
31/31 [==============================] - 0s 729us/step - loss: 1.5037 - acc: 0.7097
Epoch 3/10
31/31 [==============================] - 0s 535us/step - loss: 0.9873 - acc: 0.7097
Epoch 4/10
31/31 [==============================] - 0s 528us/step - loss: 0.7906 - acc: 0.7097
Epoch 5/10
31/31 [==============================] - 0s 365us/step - loss: 0.6501 - acc: 0.7097
Epoch 6/10
31/31 [==============================] - 0s 636us/step - loss: 0.4672 - acc: 0.8065
Epoch 7/10
31/31 [==============================] - 0s 570us/step - loss: 0.3242 - acc: 0.8387
Epoch 8/10
31/31 [==============================] - 0s 445us/step - loss: 0.2394 - acc: 0.9677
Epoch 9/10
31/31 [==============================] - 0s 481us/step - loss: 0.1801 - acc: 1.0000
Epoch 10/10
31/31 [==============================] - 0s 608us/step - loss: 0.1240 - acc: 1.0000
Epoch 1/10
206/206 [==============================] - 3s 14ms/step - loss: 2.2255 - acc: 0.1990
Epoch 2/10
206/206 [==============================] - 0s 206us/step - loss: 1.5145 - acc: 0.5097
Epoch 3/10
```

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206/206 [==============================] - 0s 308us/step - loss: 1.1850 - acc: 0.5971
Epoch 4/10
206/206 [==============================] - 0s 179us/step - loss: 0.9457 - acc: 0.7718
Epoch 5/10
206/206 [==============================] - 0s 190us/step - loss: 0.7151 - acc: 0.8252
Epoch 6/10
206/206 [==============================] - 0s 223us/step - loss: 0.5551 - acc: 0.8398
Epoch 7/10
206/206 [==============================] - 0s 243us/step - loss: 0.4040 - acc: 0.9126
Epoch 8/10
206/206 [==============================] - 0s 189us/step - loss: 0.3210 - acc: 0.9417
Epoch 9/10
206/206 [==============================] - 0s 200us/step - loss: 0.2322 - acc: 0.9515
Epoch 10/10
206/206 [==============================] - 0s 177us/step - loss: 0.1706 - acc: 0.9515
Epoch 1/10
10/10 [==============================] - 3s 285ms/step - loss: 2.3595 - acc: 0.0000e+00
Epoch 2/10
10/10 [==============================] - 0s 3ms/step - loss: 1.1019 - acc: 0.8000
Epoch 3/10
10/10 [==============================] - 0s 3ms/step - loss: 0.5295 - acc: 0.8000
Epoch 4/10
10/10 [==============================] - 0s 2ms/step - loss: 0.3546 - acc: 0.8000
Epoch 5/10
10/10 [==============================] - 0s 2ms/step - loss: 0.2376 - acc: 0.8000
Epoch 6/10
10/10 [==============================] - 0s 1ms/step - loss: 0.1269 - acc: 1.0000
Epoch 7/10
10/10 [==============================] - 0s 2ms/step - loss: 0.0556 - acc: 1.0000
Epoch 8/10
10/10 [==============================] - 0s 2ms/step - loss: 0.0240 - acc: 1.0000
Epoch 9/10
10/10 [==============================] - 0s 1ms/step - loss: 0.0129 - acc: 1.0000
Epoch 10/10
10/10 [==============================] - 0s 2ms/step - loss: 0.0096 - acc: 1.0000
Epoch 1/10
7/7 [==============================] - 3s 409ms/step - loss: 2.3358 - acc: 0.0000e+00
Epoch 2/10
7/7 [==============================] - 0s 3ms/step - loss: 0.6370 - acc: 1.0000
Epoch 3/10
7/7 [==============================] - 0s 2ms/step - loss: 0.0908 - acc: 1.0000
Epoch 4/10
7/7 [==============================] - 0s 2ms/step - loss: 0.0104 - acc: 1.0000
Epoch 5/10
7/7 [==============================] - 0s 2ms/step - loss: 0.0012 - acc: 1.0000
Epoch 6/10
7/7 [==============================] - 0s 3ms/step - loss: 1.6149e-04 - acc: 1.0000
Epoch 7/10
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7/7 [==============================] - 0s 2ms/step - loss: 2.3876e-05 - acc: 1.0000
Epoch 8/10
7/7 [==============================] - 0s 3ms/step - loss: 3.8999e-06 - acc: 1.0000
Epoch 9/10
7/7 [==============================] - 0s 3ms/step - loss: 7.3229e-07 - acc: 1.0000
Epoch 10/10
7/7 [==============================] - 0s 2ms/step - loss: 1.9584e-07 - acc: 1.0000
Epoch 1/10
111/111 [==============================] - 3s 26ms/step - loss: 2.2136 - acc: 0.1622
Epoch 2/10
111/111 [==============================] - 0s 190us/step - loss: 1.4122 - acc: 0.5045
Epoch 3/10
111/111 [==============================] - 0s 175us/step - loss: 1.0677 - acc: 0.5495
Epoch 4/10
111/111 [==============================] - 0s 189us/step - loss: 0.8402 - acc: 0.7207
Epoch 5/10
111/111 [==============================] - 0s 225us/step - loss: 0.6977 - acc: 0.8468
Epoch 6/10
111/111 [==============================] - 0s 142us/step - loss: 0.5252 - acc: 0.9099
Epoch 7/10
111/111 [==============================] - 0s 155us/step - loss: 0.4164 - acc: 0.9099
Epoch 8/10
111/111 [==============================] - 0s 207us/step - loss: 0.3375 - acc: 0.9369
Epoch 9/10
111/111 [==============================] - 0s 188us/step - loss: 0.2739 - acc: 0.9640
Epoch 10/10
111/111 [==============================] - 0s 185us/step - loss: 0.2161 - acc: 0.9730
Epoch 1/10
84/84 [==============================] - 3s 35ms/step - loss: 2.2602 - acc: 0.1190
Epoch 2/10
84/84 [==============================] - 0s 268us/step - loss: 1.6471 - acc: 0.6190
Epoch 3/10
84/84 [==============================] - 0s 214us/step - loss: 1.2406 - acc: 0.6190
Epoch 4/10
84/84 [==============================] - 0s 310us/step - loss: 0.9858 - acc: 0.6548
Epoch 5/10
84/84 [==============================] - 0s 209us/step - loss: 0.7936 - acc: 0.7500
Epoch 6/10
84/84 [==============================] - 0s 287us/step - loss: 0.6290 - acc: 0.7976
Epoch 7/10
84/84 [==============================] - 0s 277us/step - loss: 0.4889 - acc: 0.8690
Epoch 8/10
84/84 [==============================] - 0s 253us/step - loss: 0.3736 - acc: 0.9048
Epoch 9/10
84/84 [==============================] - 0s 192us/step - loss: 0.2834 - acc: 0.9524
Epoch 10/10
84/84 [==============================] - 0s 167us/step - loss: 0.2129 - acc: 0.9762
Epoch 1/10
```

```
72/72 [==============================] - 3s 41ms/step - loss: 2.4035 - acc: 0.0000e+00
Epoch 2/10
72/72 [==============================] - 0s 322us/step - loss: 1.4663 - acc: 0.8056
Epoch 3/10
72/72 [==============================] - 0s 369us/step - loss: 0.8477 - acc: 0.8056
Epoch 4/10
72/72 [==============================] - 0s 231us/step - loss: 0.5910 - acc: 0.8056
Epoch 5/10
72/72 [==============================] - 0s 302us/step - loss: 0.5147 - acc: 0.8056
Epoch 6/10
72/72 [==============================] - 0s 311us/step - loss: 0.4305 - acc: 0.8056
Epoch 7/10
72/72 [==============================] - 0s 283us/step - loss: 0.3185 - acc: 0.8611
Epoch 8/10
72/72 [==============================] - 0s 204us/step - loss: 0.2210 - acc: 0.9167
Epoch 9/10
72/72 [==============================] - 0s 276us/step - loss: 0.1674 - acc: 0.9583
Epoch 10/10
72/72 [==============================] - 0s 224us/step - loss: 0.1515 - acc: 0.9861
Epoch 1/10
1707/1707 [==============================] - 3s 2ms/step - loss: 0.6611 - acc: 0.8219
Epoch 2/10
1707/1707 [==============================] - 0s 149us/step - loss: 0.2007 - acc: 0.9455
Epoch 3/10
1707/1707 [==============================] - 0s 150us/step - loss: 0.1211 - acc: 0.9637
Epoch 4/10
1707/1707 [==============================] - 0s 164us/step - loss: 0.0734 - acc: 0.9783
Epoch 5/10
1707/1707 [==============================] - 0s 146us/step - loss: 0.0457 - acc: 0.9906
Epoch 6/10
1707/1707 [==============================] - 0s 161us/step - loss: 0.0269 - acc: 0.9930
Epoch 7/10
1707/1707 [==============================] - 0s 183us/step - loss: 0.0150 - acc: 0.9982
Epoch 8/10
1707/1707 [==============================] - 0s 163us/step - loss: 0.0083 - acc: 0.9988
Epoch 9/10
1707/1707 [==============================] - 0s 147us/step - loss: 0.0044 - acc: 1.0000
Epoch 10/10
1707/1707 [==============================] - 0s 158us/step - loss: 0.0029 - acc: 1.0000
Epoch 1/10
84/84 [==============================] - 3s 37ms/step - loss: 2.1085 - acc: 0.5119
Epoch 2/10
84/84 [==============================] - 0s 315us/step - loss: 1.3004 - acc: 0.6905
Epoch 3/10
84/84 [==============================] - 0s 258us/step - loss: 1.1051 - acc: 0.6905
Epoch 4/10
84/84 [==============================] - 0s 276us/step - loss: 1.0260 - acc: 0.6905
Epoch 5/10
```

```
84/84 [==============================] - 0s 209us/step - loss: 0.8483 - acc: 0.6905
Epoch 6/10
84/84 [==============================] - 0s 276us/step - loss: 0.6750 - acc: 0.7738
Epoch 7/10
84/84 [==============================] - 0s 174us/step - loss: 0.5855 - acc: 0.8929
Epoch 8/10
84/84 [==============================] - 0s 211us/step - loss: 0.5312 - acc: 0.9167
Epoch 9/10
84/84 [==============================] - 0s 193us/step - loss: 0.4336 - acc: 0.9167
Epoch 10/10
84/84 [==============================] - 0s 227us/step - loss: 0.3261 - acc: 0.9524
Epoch 1/10
264/264 [==============================] - 3s 12ms/step - loss: 1.8039 - acc: 0.3977
Epoch 2/10
264/264 [==============================] - 0s 176us/step - loss: 0.9615 - acc: 0.6932
Epoch 3/10
264/264 [==============================] - 0s 221us/step - loss: 0.6959 - acc: 0.8371
Epoch 4/10
264/264 [==============================] - 0s 207us/step - loss: 0.5228 - acc: 0.8750
Epoch 5/10
264/264 [==============================] - 0s 227us/step - loss: 0.3953 - acc: 0.8598
Epoch 6/10
264/264 [==============================] - 0s 212us/step - loss: 0.2821 - acc: 0.9129
Epoch 7/10
264/264 [==============================] - 0s 220us/step - loss: 0.2256 - acc: 0.9470
Epoch 8/10
264/264 [==============================] - 0s 206us/step - loss: 0.1849 - acc: 0.9470
Epoch 9/10
264/264 [==============================] - 0s 258us/step - loss: 0.1535 - acc: 0.9508
Epoch 10/10
264/264 [==============================] - 0s 190us/step - loss: 0.1147 - acc: 0.9735
Epoch 1/10
31/31 [==============================] - 3s 100ms/step - loss: 2.3180 - acc: 0.0968
Epoch 2/10
31/31 [==============================] - 0s 616us/step - loss: 1.7139 - acc: 0.4516
Epoch 3/10
31/31 [==============================] - 0s 573us/step - loss: 1.3527 - acc: 0.3871
Epoch 4/10
31/31 [==============================] - 0s 707us/step - loss: 1.0965 - acc: 0.5161
Epoch 5/10
31/31 [==============================] - 0s 618us/step - loss: 0.8514 - acc: 0.7097
Epoch 6/10
31/31 [==============================] - 0s 594us/step - loss: 0.6427 - acc: 0.9677
Epoch 7/10
31/31 [==============================] - 0s 671us/step - loss: 0.4895 - acc: 0.9677
Epoch 8/10
31/31 [==============================] - 0s 464us/step - loss: 0.3666 - acc: 0.9677
Epoch 9/10
```

```
31/31 [==============================] - 0s 629us/step - loss: 0.2658 - acc: 0.9677
Epoch 10/10
31/31 [==============================] - 0s 443us/step - loss: 0.1920 - acc: 0.9677
Epoch 1/10
557/557 [==============================] - 3s 6ms/step - loss: 1.4219 - acc: 0.4847
Epoch 2/10
557/557 [==============================] - 0s 175us/step - loss: 0.8167 - acc: 0.7792
Epoch 3/10
557/557 [==============================] - 0s 201us/step - loss: 0.5965 - acc: 0.8294
Epoch 4/10
557/557 [==============================] - 0s 179us/step - loss: 0.4406 - acc: 0.8456
Epoch 5/10
557/557 [==============================] - 0s 197us/step - loss: 0.3137 - acc: 0.9066
Epoch 6/10
557/557 [==============================] - 0s 185us/step - loss: 0.2217 - acc: 0.9408
Epoch 7/10
557/557 [==============================] - 0s 185us/step - loss: 0.1718 - acc: 0.9497
Epoch 8/10
557/557 [==============================] - 0s 214us/step - loss: 0.1437 - acc: 0.9659
Epoch 9/10
557/557 [==============================] - 0s 190us/step - loss: 0.1094 - acc: 0.9641
Epoch 10/10
557/557 [==============================] - 0s 182us/step - loss: 0.0785 - acc: 0.9838
Epoch 1/10
357/357 [==============================] - 3s 9ms/step - loss: 1.2297 - acc: 0.7199
Epoch 2/10
357/357 [==============================] - 0s 196us/step - loss: 0.7717 - acc: 0.8571
Epoch 3/10
357/357 [==============================] - 0s 172us/step - loss: 0.5374 - acc: 0.8571
Epoch 4/10
357/357 [==============================] - 0s 163us/step - loss: 0.4855 - acc: 0.8768
Epoch 5/10
357/357 [==============================] - 0s 152us/step - loss: 0.3845 - acc: 0.8880
Epoch 6/10
357/357 [==============================] - 0s 155us/step - loss: 0.3157 - acc: 0.8880
Epoch 7/10
357/357 [==============================] - 0s 140us/step - loss: 0.2494 - acc: 0.9188
Epoch 8/10
357/357 [==============================] - 0s 165us/step - loss: 0.1860 - acc: 0.9524
Epoch 9/10
357/357 [==============================] - 0s 162us/step - loss: 0.1537 - acc: 0.9636
Epoch 10/10
357/357 [==============================] - 0s 162us/step - loss: 0.1121 - acc: 0.9664
Epoch 1/10
244/244 [==============================] - 3s 13ms/step - loss: 1.9531 - acc: 0.3361
Epoch 2/10
244/244 [==============================] - 0s 188us/step - loss: 1.1422 - acc: 0.5615
Epoch 3/10
```

```
244/244 [==============================] - 0s 217us/step - loss: 0.8877 - acc: 0.7582
Epoch 4/10
244/244 [==============================] - 0s 163us/step - loss: 0.7144 - acc: 0.8115
Epoch 5/10
244/244 [==============================] - 0s 171us/step - loss: 0.5668 - acc: 0.8156
Epoch 6/10
244/244 [==============================] - 0s 183us/step - loss: 0.4354 - acc: 0.8566
Epoch 7/10
244/244 [==============================] - 0s 170us/step - loss: 0.3381 - acc: 0.9016
Epoch 8/10
244/244 [==============================] - 0s 198us/step - loss: 0.2792 - acc: 0.9385
Epoch 9/10
244/244 [==============================] - 0s 174us/step - loss: 0.2271 - acc: 0.9508
Epoch 10/10
244/244 [==============================] - 0s 172us/step - loss: 0.1679 - acc: 0.9713
Epoch 1/10
189/189 [==============================] - 3s 17ms/step - loss: 1.9318 - acc: 0.3016
Epoch 2/10
189/189 [==============================] - 0s 196us/step - loss: 0.8771 - acc: 0.7672
Epoch 3/10
189/189 [==============================] - 0s 239us/step - loss: 0.8093 - acc: 0.7672
Epoch 4/10
189/189 [==============================] - 0s 241us/step - loss: 0.5191 - acc: 0.8095
Epoch 5/10
189/189 [==============================] - 0s 214us/step - loss: 0.4627 - acc: 0.8889
Epoch 6/10
189/189 [==============================] - 0s 312us/step - loss: 0.3587 - acc: 0.9206
Epoch 7/10
189/189 [==============================] - 0s 245us/step - loss: 0.2727 - acc: 0.9206
Epoch 8/10
189/189 [==============================] - 0s 256us/step - loss: 0.2305 - acc: 0.9312
Epoch 9/10
189/189 [==============================] - 0s 219us/step - loss: 0.1714 - acc: 0.9418
Epoch 10/10
189/189 [==============================] - 0s 253us/step - loss: 0.1247 - acc: 0.9735
Epoch 1/10
93/93 [==============================] - 3s 35ms/step - loss: 2.5800 - acc: 0.0215
Epoch 2/10
93/93 [==============================] - 0s 236us/step - loss: 1.0667 - acc: 0.8065
Epoch 3/10
93/93 [==============================] - 0s 199us/step - loss: 0.7691 - acc: 0.8065
Epoch 4/10
93/93 [==============================] - 0s 251us/step - loss: 0.8096 - acc: 0.8065
Epoch 5/10
93/93 [==============================] - 0s 256us/step - loss: 0.7418 - acc: 0.8065
Epoch 6/10
93/93 [==============================] - 0s 253us/step - loss: 0.6017 - acc: 0.8065
Epoch 7/10
```

```
93/93 [==============================] - 0s 220us/step - loss: 0.4799 - acc: 0.8280
Epoch 8/10
93/93 [==============================] - 0s 196us/step - loss: 0.4595 - acc: 0.8925
Epoch 9/10
93/93 [==============================] - 0s 212us/step - loss: 0.4306 - acc: 0.9355
Epoch 10/10
93/93 [==============================] - 0s 260us/step - loss: 0.3478 - acc: 0.9140
Epoch 1/10
62/62 [==============================] - 3s 53ms/step - loss: 2.0858 - acc: 0.2581
Epoch 2/10
62/62 [==============================] - 0s 317us/step - loss: 1.2449 - acc: 0.8065
Epoch 3/10
62/62 [==============================] - 0s 244us/step - loss: 0.8396 - acc: 0.8548
Epoch 4/10
62/62 [==============================] - 0s 319us/step - loss: 0.6462 - acc: 0.8548
Epoch 5/10
62/62 [==============================] - 0s 359us/step - loss: 0.5350 - acc: 0.8710
Epoch 6/10
62/62 [==============================] - 0s 412us/step - loss: 0.4309 - acc: 0.8871
Epoch 7/10
62/62 [==============================] - 0s 262us/step - loss: 0.3215 - acc: 0.9032
Epoch 8/10
62/62 [==============================] - 0s 281us/step - loss: 0.2243 - acc: 0.9194
Epoch 9/10
62/62 [==============================] - 0s 241us/step - loss: 0.1555 - acc: 0.9677
Epoch 10/10
62/62 [==============================] - 0s 344us/step - loss: 0.1202 - acc: 0.9839
Epoch 1/10
3818/3818 [==============================] - 4s 1ms/step - loss: 0.3479 - acc: 0.9442
Epoch 2/10
3818/3818 [==============================] - 1s 144us/step - loss: 0.1418 - acc: 0.9657
Epoch 3/10
3818/3818 [==============================] - 1s 145us/step - loss: 0.0872 - acc: 0.9733
Epoch 4/10
3818/3818 [==============================] - 1s 151us/step - loss: 0.0487 - acc: 0.9874
Epoch 5/10
3818/3818 [==============================] - 1s 149us/step - loss: 0.0240 - acc: 0.9937
Epoch 6/10
3818/3818 [==============================] - 1s 154us/step - loss: 0.0141 - acc: 0.9969
Epoch 7/10
3818/3818 [==============================] - 1s 152us/step - loss: 0.0110 - acc: 0.9971
Epoch 8/10
3818/3818 [==============================] - 1s 147us/step - loss: 0.0054 - acc: 0.9992
Epoch 9/10
3818/3818 [==============================] - 1s 147us/step - loss: 0.0024 - acc: 0.9997
Epoch 10/10
3818/3818 [==============================] - 1s 149us/step - loss: 0.0013 - acc: 1.0000
Epoch 1/10
```

```
70/70 [==============================] - 3s 48ms/step - loss: 2.3236 - acc: 0.0286
Epoch 2/10
70/70 [==============================] - 0s 256us/step - loss: 1.6787 - acc: 0.6143
Epoch 3/10
70/70 [==============================] - 0s 301us/step - loss: 1.2845 - acc: 0.6143
Epoch 4/10
70/70 [==============================] - 0s 430us/step - loss: 1.0177 - acc: 0.7571
Epoch 5/10
70/70 [==============================] - 0s 210us/step - loss: 0.7954 - acc: 0.8000
Epoch 6/10
70/70 [==============================] - 0s 230us/step - loss: 0.6083 - acc: 0.8571
Epoch 7/10
70/70 [==============================] - 0s 236us/step - loss: 0.4421 - acc: 0.9143
Epoch 8/10
70/70 [==============================] - 0s 230us/step - loss: 0.3087 - acc: 0.9429
Epoch 9/10
70/70 [==============================] - 0s 306us/step - loss: 0.2153 - acc: 0.9857
Epoch 10/10
70/70 [==============================] - 0s 308us/step - loss: 0.1510 - acc: 0.9857
Epoch 1/10
44/44 [==============================] - 3s 76ms/step - loss: 2.1757 - acc: 0.0909
Epoch 2/10
44/44 [==============================] - 0s 447us/step - loss: 0.7106 - acc: 0.9318
Epoch 3/10
44/44 [==============================] - 0s 398us/step - loss: 0.3310 - acc: 0.9318
Epoch 4/10
44/44 [==============================] - 0s 419us/step - loss: 0.3269 - acc: 0.9318
Epoch 5/10
44/44 [==============================] - 0s 425us/step - loss: 0.3335 - acc: 0.9318
Epoch 6/10
44/44 [==============================] - 0s 479us/step - loss: 0.3072 - acc: 0.9318
Epoch 7/10
44/44 [==============================] - 0s 382us/step - loss: 0.2547 - acc: 0.9318
Epoch 8/10
44/44 [==============================] - 0s 449us/step - loss: 0.1880 - acc: 0.9318
Epoch 9/10
44/44 [==============================] - 0s 401us/step - loss: 0.1190 - acc: 0.9318
Epoch 10/10
44/44 [==============================] - 0s 325us/step - loss: 0.0615 - acc: 0.9545
```

```
In [11]: # predicts using the neural shrub
         def neural_shrub_predict(tree, nn_model, test, label):
             label_test = np.array(label)
             test = np.array(test)

             #row - actual; col - pred
             confusion_matrix = np.zeros((10,10), dtype=np.int)
```

```
            correct = 0

            for i in range(len(test)):
                x = test[i]
                pred_class = tree.apply([x])
                x = np.array([x])
                nn_model_class = nn_model[pred_class[0]]
                pred = np.argmax(nn_model_class.predict(x))

                confusion_matrix[label[i]][pred] = \
                    confusion_matrix[label[i]][pred] + 1
                if pred == label[i]: correct = correct + 1

            acc_score = correct/len(test)

            return confusion_matrix, acc_score
```

In [12]:
```
        # function to calculate the metrics
        def metrics(cm, cls, size):
            cm = np.array(cm)
            tp = cm[cls][cls]
            fp = sum(cm[x, cls] for x in range(10))-cm[cls][cls]
            fn = sum(cm[cls, x] for x in range(10))-cm[cls][cls]
            tn = size - tp - fp - fn
            precision = tp/(tp+fp)
            recall = tp/(tp+fn)
            fmeasure = 2*(precision*recall)/(precision + recall)
            accuracy = (tp + tn)/size

            return precision, recall, fmeasure, accuracy
```

In [13]:
```
        # Predicting
        cm, acc_score = neural_shrub_predict(tree, shrubs, test, test_label)
        print("Confusion Matrix:\n\n", cm)
```

```
Confusion Matrix:

 [[ 960    1    4    0    1    5    4    1    3    1]
 [   0 1117    4    4    0    1    4    0    5    0]
 [   6    0  970   13    5    3    8    8   18    1]
 [   4    0   14  941    1   26    1    5   13    5]
 [   1    2    1    1  920    2   12    5   12   26]
 [  10    1    2   22    2  814   14    2   20    5]
 [  12    3    3    2    6   10  915    1    6    0]
 [   1    8   15    1    4    2    0  980    5   12]
 [   1    0   16   16    5   16    3    3  904   10]
 [   4    2    3   10   19   11    0   13    7  940]]
```

```
In [14]: # Class 0
         precision0, recall0, f0, acc0 = metrics(cm, 0, len(test))
         print("        Precision Recall F-measure Accuracy")
         print("Class 0: ", round(precision0, 3), "  ", round(recall0, 3), \
               " ", round(f0, 3), "   ", round(acc0,3))

        Precision Recall F-measure Accuracy
Class 0:  0.961    0.98   0.97     0.994


In [15]: # Class 1
         precision1, recall1, f1, acc1 = metrics(cm, 1, len(test))
         print("        Precision Recall F-measure Accuracy")
         print("Class 1: ", round(precision1, 3), "  ", round(recall1, 3), \
               " ", round(f1, 3), "   ", round(acc1,3))

        Precision Recall F-measure Accuracy
Class 1:  0.985    0.984   0.985     0.996


In [16]: # Class 2
         precision2, recall2, f2, acc2 = metrics(cm, 2, len(test))
         print("        Precision Recall F-measure Accuracy")
         print("Class 2: ", round(precision2, 3), "  ", round(recall2, 3), \
               " ", round(f2, 3), "   ", round(acc2,3))

        Precision Recall F-measure Accuracy
Class 2:  0.94    0.94   0.94     0.988


In [17]: # Class 3
         precision3, recall3, f3, acc3 = metrics(cm, 3, len(test))
         print("        Precision Recall F-measure Accuracy")
         print("Class 3: ", round(precision3, 3), "  ", round(recall3, 3), \
               " ", round(f3, 3), "   ", round(acc3,3))

        Precision Recall F-measure Accuracy
Class 3:  0.932    0.932   0.932     0.986


In [18]: # Class 4
         precision4, recall4, f4, acc4 = metrics(cm, 4, len(test))
         print("        Precision Recall F-measure Accuracy")
         print("Class 4: ", round(precision4, 3), "  ", round(recall4, 3), \
               " ", round(f4, 3), "   ", round(acc4,3))

        Precision Recall F-measure Accuracy
Class 4:  0.955    0.937   0.946     0.99
```

```
In [19]: # Class 5
         precision5, recall5, f5, acc5 = metrics(cm, 5, len(test))
         print("        Precision Recall F-measure Accuracy")
         print("Class 5: ", round(precision5, 3), "   ", round(recall5, 3), \
               " ", round(f5, 3), "    ", round(acc5,3))

        Precision Recall F-measure Accuracy
Class 5:  0.915    0.913   0.914     0.985


In [20]: # Class 5
         precision5, recall5, f5, acc5 = metrics(cm, 5, len(test))
         print("        Precision Recall F-measure Accuracy")
         print("Class 5: ", round(precision5, 3), "   ", round(recall5, 3), \
               " ", round(f5, 3), "    ", round(acc5,3))

        Precision Recall F-measure Accuracy
Class 5:  0.915    0.913   0.914     0.985


In [21]: # Class 6
         precision6, recall6, f6, acc6 = metrics(cm, 6, len(test))
         print("        Precision Recall F-measure Accuracy")
         print("Class 6: ", round(precision6, 3), "   ", round(recall6, 3), \
               " ", round(f6, 3), "    ", round(acc6,3))

        Precision Recall F-measure Accuracy
Class 6:  0.952    0.955   0.954     0.991


In [22]: # Class 7
         precision7, recall7, f7, acc7 = metrics(cm, 7, len(test))
         print("        Precision Recall F-measure Accuracy")
         print("Class 7: ", round(precision0, 3), "   ", round(recall7, 3), \
               " ", round(f7, 3), "    ", round(acc7,3))

        Precision Recall F-measure Accuracy
Class 7:  0.961    0.953   0.958     0.991


In [23]: # Class 8
         precision8, recall8, f8, acc8 = metrics(cm, 8, len(test))
         print("        Precision Recall F-measure Accuracy")
         print("Class 8: ", round(precision8, 3), "   ", round(recall8, 3), \
               " ", round(f8, 3), "    ", round(acc8,3))

        Precision Recall F-measure Accuracy
Class 8:  0.91    0.928   0.919     0.984
```

```
In [24]: # Class 9
         precision9, recall9, f9, acc9 = metrics(cm, 9, len(test))
         print("        Precision Recall F-measure Accuracy")
         print("Class 9: ", round(precision9, 3), "  ", round(recall9, 3), \
               " ", round(f9, 3), "   ", round(acc9,3))

        Precision Recall F-measure Accuracy
Class 9:  0.94    0.932   0.936     0.987


In [25]: # number of instances classified correctly
         print("Accuracy_score: ", round(acc_score, 5))

Accuracy_score:  0.9461


In [26]: # training time
         total_time_taken = dt_end - dt_start + max_time
         print("Training Time: %s sec" % round(total_time_taken, 5))

Training Time: 23.32264 sec
```