Node Classification using Graph Convolutional Networks

This node classification task uses CORA dataset from https://linqs.soe.ucsc.edu/data
The dataset consists of **2708** nodes which correspond to scientific publications.
The nodes are classified into **7** categories indicating the topics of each document.
The edges indicate whether a document is cited by the other or vice versa.
Each node has **1433** features which is described by a 0/1-valued vector, indicating the bag-of-words from the dictionary.

This is an undirected graph problem

In [ ]:
```
#importing dependencies

import numpy as np
import os
import networkx as nx
from keras.utils import to_categorical
from sklearn.preprocessing import LabelEncoder
from sklearn.utils import shuffle
from sklearn.metrics import classification_report

from spektral.layers import GraphConv

from tensorflow.keras.models import Model
from tensorflow.keras.layers import Input, Dropout, Dense
from tensorflow.keras import Sequential
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.callbacks import TensorBoard, EarlyStopping
import tensorflow as tf
from tensorflow.keras.regularizers import l2

from collections import Counter
from sklearn.manifold import TSNE
import matplotlib.pyplot as plt
```

Data Loading and Preprocessing

We are going to use the edges connecting the (from file **cora.cites**).
The nodes are loaded from file **cora.content**.

In [ ]:
```
#Loading the data

all_data = []
all_edges = []

for root,dirs,files in os.walk('./cora'):
    for file in files:
        if '.content' in file:
            with open(os.path.join(root,file),'r') as f:
                all_data.extend(f.read().splitlines())
        elif 'cites' in file:
            with open(os.path.join(root,file),'r') as f:
                all_edges.extend(f.read().splitlines())


#Shuffle the data because the raw data is ordered based on the label
random_state = 77
all_data = shuffle(all_data,random_state=random_state)
```

In **cora.content** file:
The **first** element indicates the **node name**

The **second** until the last second elements indicate the **node features**
The **last** element indicates the **label of that particular node**

In **cora.cites** file:
Each line indicates the tuple of connected nodes

Parsing the data

In [ ]:
```
#parse the data
labels = []
nodes = []
X = []

for i,data in enumerate(all_data):
    elements = data.split('\t')
    labels.append(elements[-1])
    X.append(elements[1:-1])
    nodes.append(elements[0])

X = np.array(X,dtype=int)
N = X.shape[0] #the number of nodes
F = X.shape[1] #the size of node features
print('X shape: ', X.shape)


#parse the edge
edge_list=[]
for edge in all_edges:
    e = edge.split('\t')
    edge_list.append((e[0],e[1]))

print('\nNumber of nodes (N): ', N)
print('\nNumber of features (F) of each node: ', F)
print('\nCategories: ', set(labels))

num_classes = len(set(labels))
print('\nNumber of classes: ', num_classes)
```

```
X shape:  (2708, 1433)

Number of nodes (N):  2708

Number of features (F) of each node:  1433

Categories:  {'Case_Based', 'Reinforcement_Learning', 'Theory', 'Genetic_Algorithms', 'Neural_Networks', 'Rul
e_Learning', 'Probabilistic_Methods'}

Number of classes:  7
```

Select examples for training, validation, and test then set the mask

In [ ]:
```
def limit_data(labels,limit=20,val_num=500,test_num=1000):
    '''
    Get the index of train, validation, and test data
    '''
    label_counter = dict((l, 0) for l in labels)
    train_idx = []

    for i in range(len(labels)):
        label = labels[i]
        if label_counter[label]<limit:
            #add the example to the training data
            train_idx.append(i)
            label_counter[label]+=1

        #exit the loop once we found 20 examples for each class
        if all(count == limit for count in label_counter.values()):
            break
```

```
    #get the indices that do not go to traning data
    rest_idx = [x for x in range(len(labels)) if x not in train_idx]
    #get the first val_num
    val_idx = rest_idx[:val_num]
    test_idx = rest_idx[val_num:(val_num+test_num)]
    return train_idx, val_idx,test_idx


train_idx,val_idx,test_idx = limit_data(labels)
```

In [ ]:
```
#set the mask
train_mask = np.zeros((N,),dtype=bool)
train_mask[train_idx] = True

val_mask = np.zeros((N,),dtype=bool)
val_mask[val_idx] = True

test_mask = np.zeros((N,),dtype=bool)
test_mask[test_idx] = True
```

Show Data Distribution

In [ ]:
```
print("All Data Distribution: \n{}".format(Counter(labels)))
```

```
All Data Distribution:
Counter({'Neural_Networks': 818, 'Probabilistic_Methods': 426, 'Genetic_Algorithms': 418, 'Theory': 351, 'Cas
e_Based': 298, 'Reinforcement_Learning': 217, 'Rule_Learning': 180})
```

In [ ]:
```
print("Training Data Distribution: \n{}".format(Counter([labels[i] for i in train_idx])))
```

```
Training Data Distribution:
Counter({'Reinforcement_Learning': 20, 'Probabilistic_Methods': 20, 'Neural_Networks': 20, 'Case_Based': 20,
'Theory': 20, 'Genetic_Algorithms': 20, 'Rule_Learning': 20})
```

In [ ]:
```
print("Validation Data Distribution: \n{}".format(Counter([labels[i] for i in val_idx])))
```

```
Validation Data Distribution:
Counter({'Neural_Networks': 172, 'Genetic_Algorithms': 78, 'Probabilistic_Methods': 72, 'Theory': 63, 'Case_B
ased': 58, 'Reinforcement_Learning': 35, 'Rule_Learning': 22})
```

Convert the labels to one hot encoding

In [ ]:
```
def encode_label(labels):
    label_encoder = LabelEncoder()
    labels = label_encoder.fit_transform(labels)
    labels = to_categorical(labels)
    return labels, label_encoder.classes_

labels_encoded, classes = encode_label(labels)
```

Build a graph on NetworkX using the obtained nodes and edges list

In [ ]:
```
#build the graph
G = nx.Graph()
G.add_nodes_from(nodes)
G.add_edges_from(edge_list)

#obtain the adjacency matrix (A)
A = nx.adjacency_matrix(G)
print('Graph info: ', nx.info(G))
```

```
Graph info:  Name:
Type: Graph
Number of nodes: 2708
Number of edges: 5278
Average degree:   3.8981
```

Building and Training Graph Convolutional Networks

In [ ]:
```
# Parameters
channels = 16           # Number of channels in the first layer
dropout = 0.5           # Dropout rate for the features
l2_reg = 5e-4           # L2 regularization rate
learning_rate = 1e-2    # Learning rate
epochs = 700            # Number of training epochs
es_patience = 350        # Patience for early stopping

# Preprocessing operations
A = GraphConv.preprocess(A).astype('f4')

# Model definition
X_in = Input(shape=(F, ))
fltr_in = Input((N, ), sparse=True)

dropout_1 = Dropout(dropout)(X_in)
graph_conv_1 = GraphConv(channels,
                         activation='relu',
                         kernel_regularizer=l2(l2_reg),
                         use_bias=False)([dropout_1, fltr_in])

dropout_2 = Dropout(dropout)(graph_conv_1)
graph_conv_2 = GraphConv(num_classes,
                         activation='softmax',
                         use_bias=False)([dropout_2, fltr_in])

# Build model
model = Model(inputs=[X_in, fltr_in], outputs=graph_conv_2)
optimizer = Adam(lr=learning_rate)
model.compile(optimizer=optimizer,
              loss='categorical_crossentropy',
              weighted_metrics=['acc'])
model.summary()

tbCallBack_GCN = tf.keras.callbacks.TensorBoard(
    log_dir='./Tensorboard_GCN_cora',
)
callback_GCN = [tbCallBack_GCN]
```

```
Model: "model"
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_1 (InputLayer)            [(None, 1433)]       0
__________________________________________________________________________________________________
dropout (Dropout)               (None, 1433)         0           input_1[0][0]
__________________________________________________________________________________________________
input_2 (InputLayer)            [(None, 2708)]       0
__________________________________________________________________________________________________
graph_conv (GraphConv)          (None, 16)           22928       dropout[0][0]
                                                                 input_2[0][0]
__________________________________________________________________________________________________
dropout_1 (Dropout)             (None, 16)           0           graph_conv[0][0]
__________________________________________________________________________________________________
graph_conv_1 (GraphConv)        (None, 7)            112         dropout_1[0][0]
                                                                 input_2[0][0]
==================================================================================================
Total params: 23,040
Trainable params: 23,040
Non-trainable params: 0
__________________________________________________________________________________________________
```

In [ ]:
```
# Train model
validation_data = ([X, A], labels_encoded, val_mask)
model.fit([X, A],
          labels_encoded,
          sample_weight=train_mask,
          epochs=epochs,
```

```
        batch_size=N,
        validation_data=validation_data,
        shuffle=False,
        callbacks=[
            EarlyStopping(patience=es_patience,  restore_best_weights=True),
            tbCallBack_GCN
        ])
```

```
Epoch 1/700
1/1 [==============================] - 0s 365ms/step - loss: 0.1166 - acc: 0.1786 - val_loss: 0.3680 - val_ac
c: 0.2200
Epoch 2/700
1/1 [==============================] - ETA: 0s - loss: 0.1092 - acc: 0.3500WARNING:tensorflow:Method (on_trai
n_batch_end) is slow compared to the batch update (0.187574). Check your callbacks.
1/1 [==============================] - 0s 180ms/step - loss: 0.1092 - acc: 0.3500 - val_loss: 0.3559 - val_ac
c: 0.3480
Epoch 3/700
1/1 [==============================] - 0s 172ms/step - loss: 0.1030 - acc: 0.4786 - val_loss: 0.3427 - val_ac
c: 0.4920
Epoch 4/700
1/1 [==============================] - 0s 178ms/step - loss: 0.0961 - acc: 0.5857 - val_loss: 0.3285 - val_ac
c: 0.6200
Epoch 5/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0897 - acc: 0.7286 - val_loss: 0.3149 - val_ac
c: 0.7020
Epoch 6/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0844 - acc: 0.7571 - val_loss: 0.3026 - val_ac
c: 0.7420
Epoch 7/700
1/1 [==============================] - 0s 182ms/step - loss: 0.0813 - acc: 0.7571 - val_loss: 0.2918 - val_ac
c: 0.7620
Epoch 8/700
1/1 [==============================] - 0s 177ms/step - loss: 0.0776 - acc: 0.7857 - val_loss: 0.2815 - val_ac
c: 0.7740
Epoch 9/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0759 - acc: 0.8071 - val_loss: 0.2719 - val_ac
c: 0.7780
Epoch 10/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0729 - acc: 0.8071 - val_loss: 0.2631 - val_ac
c: 0.7780
Epoch 11/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0709 - acc: 0.8500 - val_loss: 0.2553 - val_ac
c: 0.7840
Epoch 12/700
1/1 [==============================] - 0s 221ms/step - loss: 0.0696 - acc: 0.8714 - val_loss: 0.2488 - val_ac
c: 0.7840
Epoch 13/700
1/1 [==============================] - 0s 249ms/step - loss: 0.0657 - acc: 0.9286 - val_loss: 0.2421 - val_ac
c: 0.7840
Epoch 14/700
1/1 [==============================] - 0s 226ms/step - loss: 0.0620 - acc: 0.9357 - val_loss: 0.2354 - val_ac
c: 0.7820
Epoch 15/700
1/1 [==============================] - 0s 237ms/step - loss: 0.0652 - acc: 0.8857 - val_loss: 0.2291 - val_ac
c: 0.7780
Epoch 16/700
1/1 [==============================] - 0s 233ms/step - loss: 0.0634 - acc: 0.8714 - val_loss: 0.2231 - val_ac
c: 0.7740
Epoch 17/700
1/1 [==============================] - 0s 238ms/step - loss: 0.0600 - acc: 0.9000 - val_loss: 0.2178 - val_ac
c: 0.7780
Epoch 18/700
1/1 [==============================] - 0s 225ms/step - loss: 0.0610 - acc: 0.9500 - val_loss: 0.2134 - val_ac
c: 0.7760
Epoch 19/700
1/1 [==============================] - 0s 225ms/step - loss: 0.0588 - acc: 0.9000 - val_loss: 0.2093 - val_ac
c: 0.7740
Epoch 20/700
1/1 [==============================] - 0s 241ms/step - loss: 0.0575 - acc: 0.9214 - val_loss: 0.2056 - val_ac
c: 0.7700
Epoch 21/700
1/1 [==============================] - 0s 254ms/step - loss: 0.0542 - acc: 0.9500 - val_loss: 0.2025 - val_ac
c: 0.7720
Epoch 22/700
1/1 [==============================] - 0s 221ms/step - loss: 0.0548 - acc: 0.9357 - val_loss: 0.1999 - val_ac
c: 0.7720
Epoch 23/700
1/1 [==============================] - 0s 218ms/step - loss: 0.0519 - acc: 0.9643 - val_loss: 0.1977 - val_ac
c: 0.7720
```

```
Epoch 24/700
1/1 [==============================] - 0s 223ms/step - loss: 0.0537 - acc: 0.9071 - val_loss: 0.1962 - val_ac
c: 0.7640
Epoch 25/700
1/1 [==============================] - 0s 212ms/step - loss: 0.0528 - acc: 0.9214 - val_loss: 0.1946 - val_ac
c: 0.7680
Epoch 26/700
1/1 [==============================] - 0s 219ms/step - loss: 0.0502 - acc: 0.9429 - val_loss: 0.1925 - val_ac
c: 0.7720
Epoch 27/700
1/1 [==============================] - 0s 226ms/step - loss: 0.0495 - acc: 0.9357 - val_loss: 0.1906 - val_ac
c: 0.7660
Epoch 28/700
1/1 [==============================] - 0s 251ms/step - loss: 0.0495 - acc: 0.9286 - val_loss: 0.1891 - val_ac
c: 0.7680
Epoch 29/700
1/1 [==============================] - 0s 248ms/step - loss: 0.0480 - acc: 0.9643 - val_loss: 0.1875 - val_ac
c: 0.7640
Epoch 30/700
1/1 [==============================] - 0s 231ms/step - loss: 0.0468 - acc: 0.9143 - val_loss: 0.1860 - val_ac
c: 0.7660
Epoch 31/700
1/1 [==============================] - 0s 211ms/step - loss: 0.0466 - acc: 0.9643 - val_loss: 0.1844 - val_ac
c: 0.7680
Epoch 32/700
1/1 [==============================] - 0s 220ms/step - loss: 0.0451 - acc: 0.9571 - val_loss: 0.1824 - val_ac
c: 0.7720
Epoch 33/700
1/1 [==============================] - 0s 219ms/step - loss: 0.0458 - acc: 0.9429 - val_loss: 0.1802 - val_ac
c: 0.7800
Epoch 34/700
1/1 [==============================] - 0s 208ms/step - loss: 0.0431 - acc: 0.9714 - val_loss: 0.1778 - val_ac
c: 0.7820
Epoch 35/700
1/1 [==============================] - 0s 209ms/step - loss: 0.0468 - acc: 0.9429 - val_loss: 0.1757 - val_ac
c: 0.7860
Epoch 36/700
1/1 [==============================] - 0s 201ms/step - loss: 0.0435 - acc: 0.9357 - val_loss: 0.1738 - val_ac
c: 0.7860
Epoch 37/700
1/1 [==============================] - 0s 199ms/step - loss: 0.0443 - acc: 0.9500 - val_loss: 0.1724 - val_ac
c: 0.7900
Epoch 38/700
1/1 [==============================] - 0s 202ms/step - loss: 0.0428 - acc: 0.9071 - val_loss: 0.1717 - val_ac
c: 0.7880
Epoch 39/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0417 - acc: 0.9500 - val_loss: 0.1714 - val_ac
c: 0.7880
Epoch 40/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0454 - acc: 0.9286 - val_loss: 0.1721 - val_ac
c: 0.7900
Epoch 41/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0412 - acc: 0.9500 - val_loss: 0.1723 - val_ac
c: 0.7860
Epoch 42/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0419 - acc: 0.9571 - val_loss: 0.1714 - val_ac
c: 0.7880
Epoch 43/700
1/1 [==============================] - 0s 180ms/step - loss: 0.0401 - acc: 0.9571 - val_loss: 0.1700 - val_ac
c: 0.7940
Epoch 44/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0416 - acc: 0.9643 - val_loss: 0.1678 - val_ac
c: 0.7940
Epoch 45/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0407 - acc: 0.9286 - val_loss: 0.1658 - val_ac
c: 0.7880
Epoch 46/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0419 - acc: 0.9500 - val_loss: 0.1642 - val_ac
c: 0.7920
Epoch 47/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0387 - acc: 0.9286 - val_loss: 0.1631 - val_ac
```

```
c: 0.7820
Epoch 48/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0394 - acc: 0.9571 - val_loss: 0.1623 - val_ac
c: 0.7860
Epoch 49/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0385 - acc: 0.9714 - val_loss: 0.1615 - val_ac
c: 0.7880
Epoch 50/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0395 - acc: 0.9500 - val_loss: 0.1612 - val_ac
c: 0.7840
Epoch 51/700
1/1 [==============================] - 0s 182ms/step - loss: 0.0381 - acc: 0.9357 - val_loss: 0.1601 - val_ac
c: 0.7820
Epoch 52/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0378 - acc: 0.9143 - val_loss: 0.1598 - val_ac
c: 0.7820
Epoch 53/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0390 - acc: 0.9571 - val_loss: 0.1595 - val_ac
c: 0.7820
Epoch 54/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0345 - acc: 0.9429 - val_loss: 0.1593 - val_ac
c: 0.7820
Epoch 55/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0354 - acc: 0.9714 - val_loss: 0.1594 - val_ac
c: 0.7800
Epoch 56/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0357 - acc: 0.9500 - val_loss: 0.1594 - val_ac
c: 0.7820
Epoch 57/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0352 - acc: 0.9714 - val_loss: 0.1589 - val_ac
c: 0.7800
Epoch 58/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0372 - acc: 0.9214 - val_loss: 0.1584 - val_ac
c: 0.7780
Epoch 59/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0351 - acc: 0.9571 - val_loss: 0.1583 - val_ac
c: 0.7780
Epoch 60/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0349 - acc: 0.9500 - val_loss: 0.1585 - val_ac
c: 0.7760
Epoch 61/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0370 - acc: 0.9643 - val_loss: 0.1581 - val_ac
c: 0.7780
Epoch 62/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0349 - acc: 0.9571 - val_loss: 0.1572 - val_ac
c: 0.7760
Epoch 63/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0353 - acc: 0.9643 - val_loss: 0.1571 - val_ac
c: 0.7780
Epoch 64/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0364 - acc: 0.9571 - val_loss: 0.1566 - val_ac
c: 0.7780
Epoch 65/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0318 - acc: 0.9786 - val_loss: 0.1557 - val_ac
c: 0.7780
Epoch 66/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0329 - acc: 0.9643 - val_loss: 0.1541 - val_ac
c: 0.7780
Epoch 67/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0320 - acc: 0.9786 - val_loss: 0.1538 - val_ac
c: 0.7800
Epoch 68/700
1/1 [==============================] - 0s 184ms/step - loss: 0.0322 - acc: 0.9714 - val_loss: 0.1544 - val_ac
c: 0.7840
Epoch 69/700
1/1 [==============================] - 0s 182ms/step - loss: 0.0329 - acc: 0.9714 - val_loss: 0.1565 - val_ac
c: 0.7780
Epoch 70/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0330 - acc: 0.9714 - val_loss: 0.1578 - val_ac
c: 0.7800
Epoch 71/700
```

```
1/1 [==============================] - 0s 169ms/step - loss: 0.0368 - acc: 0.9071 - val_loss: 0.1580 - val_ac
c: 0.7780
Epoch 72/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0339 - acc: 0.9643 - val_loss: 0.1574 - val_ac
c: 0.7800
Epoch 73/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0321 - acc: 0.9714 - val_loss: 0.1559 - val_ac
c: 0.7780
Epoch 74/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0327 - acc: 0.9643 - val_loss: 0.1543 - val_ac
c: 0.7760
Epoch 75/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0309 - acc: 0.9643 - val_loss: 0.1525 - val_ac
c: 0.7840
Epoch 76/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0327 - acc: 0.9786 - val_loss: 0.1506 - val_ac
c: 0.7840
Epoch 77/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0314 - acc: 0.9571 - val_loss: 0.1495 - val_ac
c: 0.7840
Epoch 78/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0336 - acc: 0.9286 - val_loss: 0.1490 - val_ac
c: 0.7840
Epoch 79/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0309 - acc: 0.9643 - val_loss: 0.1493 - val_ac
c: 0.7840
Epoch 80/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0316 - acc: 0.9571 - val_loss: 0.1505 - val_ac
c: 0.7840
Epoch 81/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0308 - acc: 0.9643 - val_loss: 0.1524 - val_ac
c: 0.7780
Epoch 82/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0324 - acc: 0.9571 - val_loss: 0.1539 - val_ac
c: 0.7780
Epoch 83/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0340 - acc: 0.9571 - val_loss: 0.1546 - val_ac
c: 0.7780
Epoch 84/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0297 - acc: 0.9786 - val_loss: 0.1554 - val_ac
c: 0.7820
Epoch 85/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0295 - acc: 0.9571 - val_loss: 0.1551 - val_ac
c: 0.7800
Epoch 86/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0321 - acc: 0.9643 - val_loss: 0.1547 - val_ac
c: 0.7820
Epoch 87/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0286 - acc: 0.9786 - val_loss: 0.1541 - val_ac
c: 0.7820
Epoch 88/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0343 - acc: 0.9500 - val_loss: 0.1545 - val_ac
c: 0.7860
Epoch 89/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0310 - acc: 0.9786 - val_loss: 0.1541 - val_ac
c: 0.7920
Epoch 90/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0303 - acc: 0.9714 - val_loss: 0.1535 - val_ac
c: 0.7960
Epoch 91/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0295 - acc: 0.9571 - val_loss: 0.1519 - val_ac
c: 0.7920
Epoch 92/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0310 - acc: 0.9500 - val_loss: 0.1501 - val_ac
c: 0.7820
Epoch 93/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0312 - acc: 0.9714 - val_loss: 0.1491 - val_ac
c: 0.7900
Epoch 94/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0296 - acc: 0.9714 - val_loss: 0.1493 - val_ac
c: 0.7880
```

```
Epoch 95/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0289 - acc: 0.9786 - val_loss: 0.1494 - val_ac
c: 0.7860
Epoch 96/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0280 - acc: 0.9929 - val_loss: 0.1495 - val_ac
c: 0.7860
Epoch 97/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0305 - acc: 0.9357 - val_loss: 0.1506 - val_ac
c: 0.7800
Epoch 98/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0285 - acc: 0.9571 - val_loss: 0.1519 - val_ac
c: 0.7780
Epoch 99/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0305 - acc: 0.9571 - val_loss: 0.1536 - val_ac
c: 0.7700
Epoch 100/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0324 - acc: 0.9286 - val_loss: 0.1542 - val_ac
c: 0.7740
Epoch 101/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0296 - acc: 0.9714 - val_loss: 0.1557 - val_ac
c: 0.7740
Epoch 102/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0286 - acc: 0.9857 - val_loss: 0.1565 - val_ac
c: 0.7740
Epoch 103/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0287 - acc: 0.9429 - val_loss: 0.1572 - val_ac
c: 0.7700
Epoch 104/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0278 - acc: 0.9643 - val_loss: 0.1559 - val_ac
c: 0.7720
Epoch 105/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0321 - acc: 0.9500 - val_loss: 0.1526 - val_ac
c: 0.7780
Epoch 106/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0296 - acc: 0.9500 - val_loss: 0.1484 - val_ac
c: 0.7820
Epoch 107/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0305 - acc: 0.9643 - val_loss: 0.1466 - val_ac
c: 0.7800
Epoch 108/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0284 - acc: 0.9929 - val_loss: 0.1457 - val_ac
c: 0.7840
Epoch 109/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0281 - acc: 0.9643 - val_loss: 0.1452 - val_ac
c: 0.7840
Epoch 110/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0300 - acc: 0.9357 - val_loss: 0.1457 - val_ac
c: 0.7840
Epoch 111/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0289 - acc: 0.9714 - val_loss: 0.1470 - val_ac
c: 0.7800
Epoch 112/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0259 - acc: 0.9857 - val_loss: 0.1498 - val_ac
c: 0.7680
Epoch 113/700
1/1 [==============================] - 0s 192ms/step - loss: 0.0269 - acc: 0.9714 - val_loss: 0.1519 - val_ac
c: 0.7660
Epoch 114/700
1/1 [==============================] - 0s 183ms/step - loss: 0.0272 - acc: 0.9643 - val_loss: 0.1529 - val_ac
c: 0.7620
Epoch 115/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0295 - acc: 0.9500 - val_loss: 0.1511 - val_ac
c: 0.7700
Epoch 116/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0260 - acc: 0.9857 - val_loss: 0.1494 - val_ac
c: 0.7680
Epoch 117/700
1/1 [==============================] - 0s 208ms/step - loss: 0.0272 - acc: 0.9714 - val_loss: 0.1473 - val_ac
c: 0.7640
Epoch 118/700
1/1 [==============================] - 0s 179ms/step - loss: 0.0288 - acc: 0.9500 - val_loss: 0.1445 - val_ac
```

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c: 0.7780
Epoch 119/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0269 - acc: 0.9786 - val_loss: 0.1431 - val_ac
c: 0.7860
Epoch 120/700
1/1 [==============================] - 0s 195ms/step - loss: 0.0275 - acc: 0.9429 - val_loss: 0.1440 - val_ac
c: 0.7900
Epoch 121/700
1/1 [==============================] - 0s 181ms/step - loss: 0.0242 - acc: 0.9643 - val_loss: 0.1460 - val_ac
c: 0.7880
Epoch 122/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0272 - acc: 0.9786 - val_loss: 0.1483 - val_ac
c: 0.7780
Epoch 123/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0272 - acc: 0.9786 - val_loss: 0.1502 - val_ac
c: 0.7760
Epoch 124/700
1/1 [==============================] - 0s 182ms/step - loss: 0.0269 - acc: 0.9786 - val_loss: 0.1504 - val_ac
c: 0.7840
Epoch 125/700
1/1 [==============================] - 0s 193ms/step - loss: 0.0279 - acc: 0.9643 - val_loss: 0.1495 - val_ac
c: 0.7860
Epoch 126/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0289 - acc: 0.9429 - val_loss: 0.1465 - val_ac
c: 0.7980
Epoch 127/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0266 - acc: 0.9714 - val_loss: 0.1444 - val_ac
c: 0.7960
Epoch 128/700
1/1 [==============================] - 0s 220ms/step - loss: 0.0248 - acc: 0.9857 - val_loss: 0.1436 - val_ac
c: 0.7920
Epoch 129/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0274 - acc: 0.9500 - val_loss: 0.1448 - val_ac
c: 0.7800
Epoch 130/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0276 - acc: 0.9929 - val_loss: 0.1462 - val_ac
c: 0.7720
Epoch 131/700
1/1 [==============================] - 0s 185ms/step - loss: 0.0273 - acc: 0.9643 - val_loss: 0.1459 - val_ac
c: 0.7660
Epoch 132/700
1/1 [==============================] - 0s 195ms/step - loss: 0.0251 - acc: 0.9500 - val_loss: 0.1462 - val_ac
c: 0.7660
Epoch 133/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0258 - acc: 0.9857 - val_loss: 0.1468 - val_ac
c: 0.7740
Epoch 134/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0274 - acc: 0.9714 - val_loss: 0.1480 - val_ac
c: 0.7720
Epoch 135/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0271 - acc: 0.9500 - val_loss: 0.1460 - val_ac
c: 0.7720
Epoch 136/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0253 - acc: 0.9643 - val_loss: 0.1442 - val_ac
c: 0.7740
Epoch 137/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0260 - acc: 0.9643 - val_loss: 0.1435 - val_ac
c: 0.7740
Epoch 138/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0251 - acc: 0.9714 - val_loss: 0.1443 - val_ac
c: 0.7780
Epoch 139/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0254 - acc: 0.9786 - val_loss: 0.1462 - val_ac
c: 0.7740
Epoch 140/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0260 - acc: 0.9714 - val_loss: 0.1479 - val_ac
c: 0.7700
Epoch 141/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0254 - acc: 0.9857 - val_loss: 0.1490 - val_ac
c: 0.7640
Epoch 142/700
```

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1/1 [==============================] - 0s 163ms/step - loss: 0.0245 - acc: 0.9929 - val_loss: 0.1489 - val_ac
c: 0.7600
Epoch 143/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0244 - acc: 0.9714 - val_loss: 0.1479 - val_ac
c: 0.7600
Epoch 144/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0241 - acc: 0.9857 - val_loss: 0.1469 - val_ac
c: 0.7660
Epoch 145/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0248 - acc: 0.9786 - val_loss: 0.1463 - val_ac
c: 0.7680
Epoch 146/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0264 - acc: 0.9857 - val_loss: 0.1459 - val_ac
c: 0.7640
Epoch 147/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0267 - acc: 0.9429 - val_loss: 0.1449 - val_ac
c: 0.7700
Epoch 148/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0269 - acc: 0.9429 - val_loss: 0.1429 - val_ac
c: 0.7720
Epoch 149/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0244 - acc: 0.9786 - val_loss: 0.1426 - val_ac
c: 0.7680
Epoch 150/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0253 - acc: 0.9643 - val_loss: 0.1442 - val_ac
c: 0.7700
Epoch 151/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0241 - acc: 0.9786 - val_loss: 0.1463 - val_ac
c: 0.7720
Epoch 152/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0250 - acc: 0.9714 - val_loss: 0.1473 - val_ac
c: 0.7720
Epoch 153/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0264 - acc: 0.9857 - val_loss: 0.1465 - val_ac
c: 0.7720
Epoch 154/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0261 - acc: 0.9857 - val_loss: 0.1457 - val_ac
c: 0.7680
Epoch 155/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0242 - acc: 0.9714 - val_loss: 0.1452 - val_ac
c: 0.7660
Epoch 156/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0250 - acc: 0.9571 - val_loss: 0.1433 - val_ac
c: 0.7680
Epoch 157/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0245 - acc: 0.9786 - val_loss: 0.1412 - val_ac
c: 0.7700
Epoch 158/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0254 - acc: 0.9786 - val_loss: 0.1411 - val_ac
c: 0.7760
Epoch 159/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0233 - acc: 0.9857 - val_loss: 0.1422 - val_ac
c: 0.7700
Epoch 160/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0229 - acc: 0.9857 - val_loss: 0.1433 - val_ac
c: 0.7680
Epoch 161/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0254 - acc: 0.9571 - val_loss: 0.1439 - val_ac
c: 0.7700
Epoch 162/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0252 - acc: 0.9929 - val_loss: 0.1449 - val_ac
c: 0.7640
Epoch 163/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0250 - acc: 0.9643 - val_loss: 0.1461 - val_ac
c: 0.7720
Epoch 164/700
1/1 [==============================] - 0s 159ms/step - loss: 0.0221 - acc: 0.9786 - val_loss: 0.1469 - val_ac
c: 0.7660
Epoch 165/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0258 - acc: 0.9714 - val_loss: 0.1477 - val_ac
c: 0.7700
```

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Epoch 166/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0227 - acc: 0.9786 - val_loss: 0.1466 - val_ac
c: 0.7740
Epoch 167/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0235 - acc: 0.9714 - val_loss: 0.1444 - val_ac
c: 0.7760
Epoch 168/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0243 - acc: 0.9857 - val_loss: 0.1424 - val_ac
c: 0.7800
Epoch 169/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0254 - acc: 0.9714 - val_loss: 0.1425 - val_ac
c: 0.7720
Epoch 170/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0225 - acc: 0.9857 - val_loss: 0.1418 - val_ac
c: 0.7800
Epoch 171/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0242 - acc: 0.9714 - val_loss: 0.1406 - val_ac
c: 0.7800
Epoch 172/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0253 - acc: 0.9714 - val_loss: 0.1392 - val_ac
c: 0.7800
Epoch 173/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0231 - acc: 0.9714 - val_loss: 0.1399 - val_ac
c: 0.7740
Epoch 174/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0230 - acc: 0.9786 - val_loss: 0.1418 - val_ac
c: 0.7740
Epoch 175/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0249 - acc: 0.9643 - val_loss: 0.1457 - val_ac
c: 0.7720
Epoch 176/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0243 - acc: 0.9714 - val_loss: 0.1480 - val_ac
c: 0.7740
Epoch 177/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0239 - acc: 0.9857 - val_loss: 0.1492 - val_ac
c: 0.7680
Epoch 178/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0236 - acc: 0.9786 - val_loss: 0.1479 - val_ac
c: 0.7840
Epoch 179/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0237 - acc: 0.9857 - val_loss: 0.1456 - val_ac
c: 0.8000
Epoch 180/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0227 - acc: 0.9714 - val_loss: 0.1433 - val_ac
c: 0.7960
Epoch 181/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0236 - acc: 0.9786 - val_loss: 0.1416 - val_ac
c: 0.7900
Epoch 182/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0239 - acc: 0.9786 - val_loss: 0.1405 - val_ac
c: 0.7920
Epoch 183/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0236 - acc: 0.9857 - val_loss: 0.1382 - val_ac
c: 0.7960
Epoch 184/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0233 - acc: 0.9786 - val_loss: 0.1366 - val_ac
c: 0.7960
Epoch 185/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0242 - acc: 0.9643 - val_loss: 0.1375 - val_ac
c: 0.7800
Epoch 186/700
1/1 [==============================] - 0s 178ms/step - loss: 0.0213 - acc: 0.9714 - val_loss: 0.1407 - val_ac
c: 0.7760
Epoch 187/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0239 - acc: 0.9786 - val_loss: 0.1458 - val_ac
c: 0.7720
Epoch 188/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0249 - acc: 0.9571 - val_loss: 0.1475 - val_ac
c: 0.7660
Epoch 189/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0232 - acc: 0.9714 - val_loss: 0.1488 - val_ac
```

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c: 0.7620
Epoch 190/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0260 - acc: 0.9643 - val_loss: 0.1496 - val_ac
c: 0.7520
Epoch 191/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0242 - acc: 0.9643 - val_loss: 0.1493 - val_ac
c: 0.7680
Epoch 192/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0231 - acc: 0.9786 - val_loss: 0.1507 - val_ac
c: 0.7660
Epoch 193/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0240 - acc: 0.9714 - val_loss: 0.1504 - val_ac
c: 0.7620
Epoch 194/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0238 - acc: 0.9786 - val_loss: 0.1470 - val_ac
c: 0.7680
Epoch 195/700
1/1 [==============================] - 0s 188ms/step - loss: 0.0236 - acc: 0.9643 - val_loss: 0.1440 - val_ac
c: 0.7760
Epoch 196/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0233 - acc: 0.9714 - val_loss: 0.1433 - val_ac
c: 0.7760
Epoch 197/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0223 - acc: 0.9857 - val_loss: 0.1441 - val_ac
c: 0.7720
Epoch 198/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0230 - acc: 0.9929 - val_loss: 0.1474 - val_ac
c: 0.7660
Epoch 199/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0208 - acc: 0.9929 - val_loss: 0.1506 - val_ac
c: 0.7600
Epoch 200/700
1/1 [==============================] - 0s 182ms/step - loss: 0.0241 - acc: 0.9571 - val_loss: 0.1495 - val_ac
c: 0.7580
Epoch 201/700
1/1 [==============================] - 0s 180ms/step - loss: 0.0226 - acc: 0.9857 - val_loss: 0.1476 - val_ac
c: 0.7680
Epoch 202/700
1/1 [==============================] - 0s 181ms/step - loss: 0.0227 - acc: 0.9786 - val_loss: 0.1447 - val_ac
c: 0.7700
Epoch 203/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0225 - acc: 0.9714 - val_loss: 0.1415 - val_ac
c: 0.7720
Epoch 204/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0217 - acc: 0.9786 - val_loss: 0.1404 - val_ac
c: 0.7780
Epoch 205/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0221 - acc: 0.9786 - val_loss: 0.1394 - val_ac
c: 0.7840
Epoch 206/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0260 - acc: 0.9500 - val_loss: 0.1422 - val_ac
c: 0.7680
Epoch 207/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0236 - acc: 0.9714 - val_loss: 0.1450 - val_ac
c: 0.7620
Epoch 208/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0236 - acc: 0.9643 - val_loss: 0.1470 - val_ac
c: 0.7620
Epoch 209/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0225 - acc: 0.9571 - val_loss: 0.1482 - val_ac
c: 0.7600
Epoch 210/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0239 - acc: 0.9714 - val_loss: 0.1465 - val_ac
c: 0.7580
Epoch 211/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0198 - acc: 0.9929 - val_loss: 0.1436 - val_ac
c: 0.7620
Epoch 212/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0234 - acc: 0.9571 - val_loss: 0.1408 - val_ac
c: 0.7620
Epoch 213/700
```

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1/1 [==============================] - 0s 173ms/step - loss: 0.0228 - acc: 0.9786 - val_loss: 0.1387 - val_ac
c: 0.7660
Epoch 214/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0244 - acc: 0.9643 - val_loss: 0.1382 - val_ac
c: 0.7580
Epoch 215/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0224 - acc: 0.9714 - val_loss: 0.1375 - val_ac
c: 0.7620
Epoch 216/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0211 - acc: 0.9857 - val_loss: 0.1368 - val_ac
c: 0.7620
Epoch 217/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0234 - acc: 0.9786 - val_loss: 0.1355 - val_ac
c: 0.7660
Epoch 218/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0213 - acc: 0.9786 - val_loss: 0.1349 - val_ac
c: 0.7720
Epoch 219/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0211 - acc: 0.9929 - val_loss: 0.1356 - val_ac
c: 0.7780
Epoch 220/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0253 - acc: 0.9500 - val_loss: 0.1374 - val_ac
c: 0.7800
Epoch 221/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0217 - acc: 0.9571 - val_loss: 0.1405 - val_ac
c: 0.7780
Epoch 222/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0202 - acc: 1.0000 - val_loss: 0.1456 - val_ac
c: 0.7740
Epoch 223/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0236 - acc: 0.9643 - val_loss: 0.1467 - val_ac
c: 0.7720
Epoch 224/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0220 - acc: 0.9643 - val_loss: 0.1442 - val_ac
c: 0.7740
Epoch 225/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0227 - acc: 0.9714 - val_loss: 0.1429 - val_ac
c: 0.7780
Epoch 226/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0216 - acc: 0.9786 - val_loss: 0.1409 - val_ac
c: 0.7780
Epoch 227/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0224 - acc: 0.9643 - val_loss: 0.1391 - val_ac
c: 0.7860
Epoch 228/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0199 - acc: 0.9857 - val_loss: 0.1383 - val_ac
c: 0.7820
Epoch 229/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0221 - acc: 0.9786 - val_loss: 0.1381 - val_ac
c: 0.7840
Epoch 230/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0219 - acc: 0.9714 - val_loss: 0.1384 - val_ac
c: 0.7740
Epoch 231/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0209 - acc: 0.9929 - val_loss: 0.1405 - val_ac
c: 0.7780
Epoch 232/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0209 - acc: 0.9786 - val_loss: 0.1433 - val_ac
c: 0.7680
Epoch 233/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0213 - acc: 0.9929 - val_loss: 0.1462 - val_ac
c: 0.7600
Epoch 234/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0216 - acc: 0.9857 - val_loss: 0.1468 - val_ac
c: 0.7600
Epoch 235/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0205 - acc: 0.9929 - val_loss: 0.1449 - val_ac
c: 0.7660
Epoch 236/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0228 - acc: 0.9643 - val_loss: 0.1418 - val_ac
c: 0.7780
```

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Epoch 237/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0226 - acc: 0.9714 - val_loss: 0.1405 - val_ac
c: 0.7860
Epoch 238/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0223 - acc: 0.9786 - val_loss: 0.1410 - val_ac
c: 0.7800
Epoch 239/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0221 - acc: 0.9857 - val_loss: 0.1406 - val_ac
c: 0.7820
Epoch 240/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0240 - acc: 0.9429 - val_loss: 0.1418 - val_ac
c: 0.7740
Epoch 241/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0224 - acc: 0.9571 - val_loss: 0.1433 - val_ac
c: 0.7600
Epoch 242/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0210 - acc: 0.9786 - val_loss: 0.1442 - val_ac
c: 0.7600
Epoch 243/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0214 - acc: 0.9857 - val_loss: 0.1446 - val_ac
c: 0.7540
Epoch 244/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0201 - acc: 0.9643 - val_loss: 0.1418 - val_ac
c: 0.7640
Epoch 245/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0224 - acc: 0.9643 - val_loss: 0.1393 - val_ac
c: 0.7620
Epoch 246/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0207 - acc: 0.9857 - val_loss: 0.1403 - val_ac
c: 0.7640
Epoch 247/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0206 - acc: 1.0000 - val_loss: 0.1429 - val_ac
c: 0.7620
Epoch 248/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0215 - acc: 0.9714 - val_loss: 0.1464 - val_ac
c: 0.7600
Epoch 249/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0217 - acc: 0.9786 - val_loss: 0.1473 - val_ac
c: 0.7580
Epoch 250/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0203 - acc: 0.9857 - val_loss: 0.1461 - val_ac
c: 0.7580
Epoch 251/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0205 - acc: 0.9857 - val_loss: 0.1455 - val_ac
c: 0.7540
Epoch 252/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0212 - acc: 0.9714 - val_loss: 0.1421 - val_ac
c: 0.7660
Epoch 253/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0211 - acc: 0.9786 - val_loss: 0.1380 - val_ac
c: 0.7740
Epoch 254/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0187 - acc: 1.0000 - val_loss: 0.1350 - val_ac
c: 0.7840
Epoch 255/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0216 - acc: 0.9643 - val_loss: 0.1354 - val_ac
c: 0.7860
Epoch 256/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0200 - acc: 0.9786 - val_loss: 0.1373 - val_ac
c: 0.7780
Epoch 257/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0186 - acc: 0.9786 - val_loss: 0.1389 - val_ac
c: 0.7700
Epoch 258/700
1/1 [==============================] - 0s 158ms/step - loss: 0.0207 - acc: 0.9786 - val_loss: 0.1401 - val_ac
c: 0.7640
Epoch 259/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0232 - acc: 0.9571 - val_loss: 0.1402 - val_ac
c: 0.7580
Epoch 260/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0188 - acc: 0.9786 - val_loss: 0.1416 - val_ac
```

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c: 0.7560
Epoch 261/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0194 - acc: 0.9857 - val_loss: 0.1418 - val_ac
c: 0.7580
Epoch 262/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0194 - acc: 0.9786 - val_loss: 0.1410 - val_ac
c: 0.7600
Epoch 263/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0186 - acc: 1.0000 - val_loss: 0.1404 - val_ac
c: 0.7640
Epoch 264/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0200 - acc: 0.9857 - val_loss: 0.1399 - val_ac
c: 0.7660
Epoch 265/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0190 - acc: 0.9929 - val_loss: 0.1388 - val_ac
c: 0.7600
Epoch 266/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0216 - acc: 0.9786 - val_loss: 0.1366 - val_ac
c: 0.7660
Epoch 267/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0189 - acc: 0.9929 - val_loss: 0.1329 - val_ac
c: 0.7680
Epoch 268/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0209 - acc: 0.9500 - val_loss: 0.1306 - val_ac
c: 0.7720
Epoch 269/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0200 - acc: 0.9857 - val_loss: 0.1317 - val_ac
c: 0.7840
Epoch 270/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0190 - acc: 0.9786 - val_loss: 0.1349 - val_ac
c: 0.7820
Epoch 271/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0194 - acc: 0.9929 - val_loss: 0.1391 - val_ac
c: 0.7620
Epoch 272/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0204 - acc: 0.9714 - val_loss: 0.1393 - val_ac
c: 0.7660
Epoch 273/700
1/1 [==============================] - 0s 181ms/step - loss: 0.0200 - acc: 0.9714 - val_loss: 0.1392 - val_ac
c: 0.7640
Epoch 274/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0200 - acc: 0.9786 - val_loss: 0.1384 - val_ac
c: 0.7700
Epoch 275/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0188 - acc: 0.9857 - val_loss: 0.1382 - val_ac
c: 0.7720
Epoch 276/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0228 - acc: 0.9857 - val_loss: 0.1371 - val_ac
c: 0.7720
Epoch 277/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0212 - acc: 0.9714 - val_loss: 0.1367 - val_ac
c: 0.7780
Epoch 278/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0205 - acc: 0.9857 - val_loss: 0.1351 - val_ac
c: 0.7700
Epoch 279/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0192 - acc: 0.9857 - val_loss: 0.1334 - val_ac
c: 0.7720
Epoch 280/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0211 - acc: 0.9786 - val_loss: 0.1333 - val_ac
c: 0.7700
Epoch 281/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0212 - acc: 0.9571 - val_loss: 0.1341 - val_ac
c: 0.7680
Epoch 282/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0188 - acc: 0.9786 - val_loss: 0.1367 - val_ac
c: 0.7660
Epoch 283/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0210 - acc: 0.9786 - val_loss: 0.1399 - val_ac
c: 0.7640
Epoch 284/700
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1/1 [==============================] - 0s 167ms/step - loss: 0.0192 - acc: 0.9857 - val_loss: 0.1429 - val_ac
c: 0.7560
Epoch 285/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0212 - acc: 0.9786 - val_loss: 0.1442 - val_ac
c: 0.7580
Epoch 286/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0204 - acc: 0.9714 - val_loss: 0.1432 - val_ac
c: 0.7620
Epoch 287/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0207 - acc: 0.9786 - val_loss: 0.1420 - val_ac
c: 0.7800
Epoch 288/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0205 - acc: 0.9786 - val_loss: 0.1398 - val_ac
c: 0.7800
Epoch 289/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0195 - acc: 0.9643 - val_loss: 0.1365 - val_ac
c: 0.7840
Epoch 290/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0189 - acc: 0.9786 - val_loss: 0.1334 - val_ac
c: 0.7880
Epoch 291/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0186 - acc: 0.9857 - val_loss: 0.1320 - val_ac
c: 0.7860
Epoch 292/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0208 - acc: 0.9786 - val_loss: 0.1336 - val_ac
c: 0.7820
Epoch 293/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0219 - acc: 0.9500 - val_loss: 0.1382 - val_ac
c: 0.7700
Epoch 294/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0213 - acc: 0.9714 - val_loss: 0.1441 - val_ac
c: 0.7640
Epoch 295/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0195 - acc: 0.9786 - val_loss: 0.1503 - val_ac
c: 0.7580
Epoch 296/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0187 - acc: 0.9929 - val_loss: 0.1514 - val_ac
c: 0.7620
Epoch 297/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0214 - acc: 0.9714 - val_loss: 0.1485 - val_ac
c: 0.7660
Epoch 298/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0203 - acc: 0.9786 - val_loss: 0.1443 - val_ac
c: 0.7700
Epoch 299/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0184 - acc: 0.9857 - val_loss: 0.1412 - val_ac
c: 0.7840
Epoch 300/700
1/1 [==============================] - 0s 158ms/step - loss: 0.0191 - acc: 0.9857 - val_loss: 0.1406 - val_ac
c: 0.7820
Epoch 301/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0185 - acc: 0.9786 - val_loss: 0.1402 - val_ac
c: 0.7820
Epoch 302/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0209 - acc: 0.9929 - val_loss: 0.1369 - val_ac
c: 0.7840
Epoch 303/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0193 - acc: 0.9786 - val_loss: 0.1343 - val_ac
c: 0.7820
Epoch 304/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0188 - acc: 0.9857 - val_loss: 0.1321 - val_ac
c: 0.7820
Epoch 305/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0207 - acc: 0.9786 - val_loss: 0.1315 - val_ac
c: 0.7800
Epoch 306/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0189 - acc: 0.9857 - val_loss: 0.1325 - val_ac
c: 0.7800
Epoch 307/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0211 - acc: 0.9643 - val_loss: 0.1332 - val_ac
c: 0.7700
```

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Epoch 308/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0192 - acc: 0.9786 - val_loss: 0.1354 - val_ac
c: 0.7700
Epoch 309/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0203 - acc: 0.9786 - val_loss: 0.1366 - val_ac
c: 0.7720
Epoch 310/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0194 - acc: 0.9643 - val_loss: 0.1389 - val_ac
c: 0.7660
Epoch 311/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0187 - acc: 0.9929 - val_loss: 0.1417 - val_ac
c: 0.7680
Epoch 312/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0169 - acc: 0.9857 - val_loss: 0.1444 - val_ac
c: 0.7720
Epoch 313/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0194 - acc: 0.9857 - val_loss: 0.1457 - val_ac
c: 0.7680
Epoch 314/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0176 - acc: 0.9857 - val_loss: 0.1444 - val_ac
c: 0.7760
Epoch 315/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0184 - acc: 0.9929 - val_loss: 0.1410 - val_ac
c: 0.7780
Epoch 316/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0196 - acc: 0.9786 - val_loss: 0.1370 - val_ac
c: 0.7900
Epoch 317/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0181 - acc: 0.9857 - val_loss: 0.1330 - val_ac
c: 0.7920
Epoch 318/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0201 - acc: 0.9643 - val_loss: 0.1301 - val_ac
c: 0.7940
Epoch 319/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0212 - acc: 0.9500 - val_loss: 0.1309 - val_ac
c: 0.7960
Epoch 320/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0209 - acc: 0.9643 - val_loss: 0.1345 - val_ac
c: 0.7860
Epoch 321/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0183 - acc: 0.9857 - val_loss: 0.1380 - val_ac
c: 0.7780
Epoch 322/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0219 - acc: 0.9571 - val_loss: 0.1404 - val_ac
c: 0.7700
Epoch 323/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0210 - acc: 0.9643 - val_loss: 0.1406 - val_ac
c: 0.7720
Epoch 324/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0192 - acc: 0.9714 - val_loss: 0.1415 - val_ac
c: 0.7700
Epoch 325/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0185 - acc: 0.9857 - val_loss: 0.1430 - val_ac
c: 0.7660
Epoch 326/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0208 - acc: 0.9786 - val_loss: 0.1459 - val_ac
c: 0.7600
Epoch 327/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0188 - acc: 0.9786 - val_loss: 0.1472 - val_ac
c: 0.7520
Epoch 328/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0195 - acc: 0.9714 - val_loss: 0.1453 - val_ac
c: 0.7500
Epoch 329/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0205 - acc: 0.9714 - val_loss: 0.1425 - val_ac
c: 0.7620
Epoch 330/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0209 - acc: 0.9643 - val_loss: 0.1404 - val_ac
c: 0.7840
Epoch 331/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0195 - acc: 0.9714 - val_loss: 0.1400 - val_ac
```

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c: 0.7840
Epoch 332/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0199 - acc: 0.9714 - val_loss: 0.1385 - val_ac
c: 0.7800
Epoch 333/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0193 - acc: 0.9643 - val_loss: 0.1382 - val_ac
c: 0.7800
Epoch 334/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0182 - acc: 0.9857 - val_loss: 0.1386 - val_ac
c: 0.7760
Epoch 335/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0205 - acc: 0.9786 - val_loss: 0.1399 - val_ac
c: 0.7800
Epoch 336/700
1/1 [==============================] - 0s 182ms/step - loss: 0.0176 - acc: 0.9929 - val_loss: 0.1432 - val_ac
c: 0.7620
Epoch 337/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0196 - acc: 0.9786 - val_loss: 0.1443 - val_ac
c: 0.7660
Epoch 338/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0190 - acc: 0.9857 - val_loss: 0.1448 - val_ac
c: 0.7620
Epoch 339/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0222 - acc: 0.9500 - val_loss: 0.1460 - val_ac
c: 0.7680
Epoch 340/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0190 - acc: 0.9929 - val_loss: 0.1474 - val_ac
c: 0.7640
Epoch 341/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0194 - acc: 0.9929 - val_loss: 0.1471 - val_ac
c: 0.7640
Epoch 342/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0218 - acc: 0.9714 - val_loss: 0.1468 - val_ac
c: 0.7640
Epoch 343/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0203 - acc: 0.9714 - val_loss: 0.1462 - val_ac
c: 0.7760
Epoch 344/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0199 - acc: 0.9643 - val_loss: 0.1447 - val_ac
c: 0.7780
Epoch 345/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0179 - acc: 0.9786 - val_loss: 0.1425 - val_ac
c: 0.7760
Epoch 346/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0195 - acc: 0.9857 - val_loss: 0.1420 - val_ac
c: 0.7760
Epoch 347/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0228 - acc: 0.9714 - val_loss: 0.1427 - val_ac
c: 0.7800
Epoch 348/700
1/1 [==============================] - 0s 180ms/step - loss: 0.0196 - acc: 0.9786 - val_loss: 0.1414 - val_ac
c: 0.7720
Epoch 349/700
1/1 [==============================] - 0s 178ms/step - loss: 0.0213 - acc: 0.9571 - val_loss: 0.1406 - val_ac
c: 0.7720
Epoch 350/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0208 - acc: 0.9571 - val_loss: 0.1398 - val_ac
c: 0.7740
Epoch 351/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0200 - acc: 0.9786 - val_loss: 0.1370 - val_ac
c: 0.7740
Epoch 352/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0195 - acc: 0.9857 - val_loss: 0.1366 - val_ac
c: 0.7780
Epoch 353/700
1/1 [==============================] - 0s 159ms/step - loss: 0.0197 - acc: 0.9786 - val_loss: 0.1367 - val_ac
c: 0.7800
Epoch 354/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0184 - acc: 0.9714 - val_loss: 0.1380 - val_ac
c: 0.7800
Epoch 355/700
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1/1 [==============================] - 0s 166ms/step - loss: 0.0187 - acc: 0.9929 - val_loss: 0.1416 - val_ac
c: 0.7880
Epoch 356/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0196 - acc: 0.9786 - val_loss: 0.1433 - val_ac
c: 0.7780
Epoch 357/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0175 - acc: 0.9929 - val_loss: 0.1444 - val_ac
c: 0.7800
Epoch 358/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0200 - acc: 0.9714 - val_loss: 0.1424 - val_ac
c: 0.7840
Epoch 359/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0198 - acc: 0.9714 - val_loss: 0.1407 - val_ac
c: 0.7780
Epoch 360/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0184 - acc: 0.9714 - val_loss: 0.1392 - val_ac
c: 0.7780
Epoch 361/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0173 - acc: 0.9857 - val_loss: 0.1384 - val_ac
c: 0.7780
Epoch 362/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0191 - acc: 0.9714 - val_loss: 0.1375 - val_ac
c: 0.7760
Epoch 363/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0175 - acc: 0.9857 - val_loss: 0.1371 - val_ac
c: 0.7720
Epoch 364/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0181 - acc: 0.9929 - val_loss: 0.1382 - val_ac
c: 0.7780
Epoch 365/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0183 - acc: 0.9786 - val_loss: 0.1408 - val_ac
c: 0.7740
Epoch 366/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0192 - acc: 0.9786 - val_loss: 0.1454 - val_ac
c: 0.7680
Epoch 367/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0194 - acc: 0.9857 - val_loss: 0.1467 - val_ac
c: 0.7640
Epoch 368/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0196 - acc: 0.9643 - val_loss: 0.1459 - val_ac
c: 0.7720
Epoch 369/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0175 - acc: 0.9857 - val_loss: 0.1430 - val_ac
c: 0.7760
Epoch 370/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0177 - acc: 0.9786 - val_loss: 0.1400 - val_ac
c: 0.7700
Epoch 371/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0182 - acc: 0.9714 - val_loss: 0.1381 - val_ac
c: 0.7640
Epoch 372/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0200 - acc: 0.9643 - val_loss: 0.1376 - val_ac
c: 0.7720
Epoch 373/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0188 - acc: 0.9714 - val_loss: 0.1381 - val_ac
c: 0.7780
Epoch 374/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0192 - acc: 0.9786 - val_loss: 0.1391 - val_ac
c: 0.7800
Epoch 375/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0173 - acc: 1.0000 - val_loss: 0.1394 - val_ac
c: 0.7820
Epoch 376/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0200 - acc: 0.9786 - val_loss: 0.1369 - val_ac
c: 0.7820
Epoch 377/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0193 - acc: 0.9857 - val_loss: 0.1366 - val_ac
c: 0.7780
Epoch 378/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0182 - acc: 0.9857 - val_loss: 0.1363 - val_ac
c: 0.7800
```

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Epoch 379/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0188 - acc: 0.9857 - val_loss: 0.1351 - val_ac
c: 0.7840
Epoch 380/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0189 - acc: 0.9786 - val_loss: 0.1369 - val_ac
c: 0.7820
Epoch 381/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0184 - acc: 0.9714 - val_loss: 0.1402 - val_ac
c: 0.7820
Epoch 382/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0173 - acc: 0.9929 - val_loss: 0.1436 - val_ac
c: 0.7740
Epoch 383/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0187 - acc: 0.9786 - val_loss: 0.1474 - val_ac
c: 0.7720
Epoch 384/700
1/1 [==============================] - 0s 193ms/step - loss: 0.0192 - acc: 0.9857 - val_loss: 0.1470 - val_ac
c: 0.7640
Epoch 385/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0182 - acc: 0.9786 - val_loss: 0.1449 - val_ac
c: 0.7580
Epoch 386/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0192 - acc: 0.9643 - val_loss: 0.1420 - val_ac
c: 0.7580
Epoch 387/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0184 - acc: 0.9929 - val_loss: 0.1395 - val_ac
c: 0.7620
Epoch 388/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0183 - acc: 0.9714 - val_loss: 0.1400 - val_ac
c: 0.7620
Epoch 389/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0167 - acc: 0.9929 - val_loss: 0.1413 - val_ac
c: 0.7680
Epoch 390/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0206 - acc: 0.9643 - val_loss: 0.1414 - val_ac
c: 0.7600
Epoch 391/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0192 - acc: 0.9857 - val_loss: 0.1424 - val_ac
c: 0.7600
Epoch 392/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0194 - acc: 0.9786 - val_loss: 0.1424 - val_ac
c: 0.7640
Epoch 393/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0195 - acc: 0.9500 - val_loss: 0.1429 - val_ac
c: 0.7580
Epoch 394/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0187 - acc: 0.9857 - val_loss: 0.1453 - val_ac
c: 0.7480
Epoch 395/700
1/1 [==============================] - 0s 178ms/step - loss: 0.0180 - acc: 0.9643 - val_loss: 0.1451 - val_ac
c: 0.7480
Epoch 396/700
1/1 [==============================] - 0s 194ms/step - loss: 0.0179 - acc: 0.9786 - val_loss: 0.1441 - val_ac
c: 0.7480
Epoch 397/700
1/1 [==============================] - 0s 181ms/step - loss: 0.0175 - acc: 0.9714 - val_loss: 0.1436 - val_ac
c: 0.7460
Epoch 398/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0182 - acc: 0.9857 - val_loss: 0.1430 - val_ac
c: 0.7480
Epoch 399/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0196 - acc: 0.9786 - val_loss: 0.1441 - val_ac
c: 0.7460
Epoch 400/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0172 - acc: 0.9786 - val_loss: 0.1461 - val_ac
c: 0.7460
Epoch 401/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0171 - acc: 0.9857 - val_loss: 0.1480 - val_ac
c: 0.7500
Epoch 402/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0175 - acc: 0.9714 - val_loss: 0.1475 - val_ac
```

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c: 0.7460
Epoch 403/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0171 - acc: 0.9857 - val_loss: 0.1446 - val_ac
c: 0.7520
Epoch 404/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0186 - acc: 0.9714 - val_loss: 0.1426 - val_ac
c: 0.7580
Epoch 405/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0197 - acc: 0.9714 - val_loss: 0.1417 - val_ac
c: 0.7640
Epoch 406/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0185 - acc: 0.9714 - val_loss: 0.1408 - val_ac
c: 0.7740
Epoch 407/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0180 - acc: 0.9643 - val_loss: 0.1407 - val_ac
c: 0.7740
Epoch 408/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0170 - acc: 0.9929 - val_loss: 0.1424 - val_ac
c: 0.7680
Epoch 409/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0176 - acc: 0.9857 - val_loss: 0.1422 - val_ac
c: 0.7660
Epoch 410/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0162 - acc: 0.9857 - val_loss: 0.1413 - val_ac
c: 0.7760
Epoch 411/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0180 - acc: 0.9929 - val_loss: 0.1413 - val_ac
c: 0.7760
Epoch 412/700
1/1 [==============================] - 0s 182ms/step - loss: 0.0191 - acc: 0.9714 - val_loss: 0.1413 - val_ac
c: 0.7820
Epoch 413/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0186 - acc: 0.9786 - val_loss: 0.1418 - val_ac
c: 0.7800
Epoch 414/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0184 - acc: 0.9643 - val_loss: 0.1417 - val_ac
c: 0.7760
Epoch 415/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0176 - acc: 0.9857 - val_loss: 0.1456 - val_ac
c: 0.7580
Epoch 416/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0175 - acc: 0.9857 - val_loss: 0.1491 - val_ac
c: 0.7520
Epoch 417/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0185 - acc: 0.9786 - val_loss: 0.1492 - val_ac
c: 0.7540
Epoch 418/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0188 - acc: 0.9786 - val_loss: 0.1456 - val_ac
c: 0.7580
Epoch 419/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0186 - acc: 0.9714 - val_loss: 0.1420 - val_ac
c: 0.7740
Epoch 420/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0198 - acc: 0.9643 - val_loss: 0.1367 - val_ac
c: 0.7940
Epoch 421/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0198 - acc: 0.9786 - val_loss: 0.1341 - val_ac
c: 0.7940
Epoch 422/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0182 - acc: 0.9929 - val_loss: 0.1341 - val_ac
c: 0.7940
Epoch 423/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0163 - acc: 0.9929 - val_loss: 0.1351 - val_ac
c: 0.7860
Epoch 424/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0176 - acc: 0.9929 - val_loss: 0.1373 - val_ac
c: 0.7800
Epoch 425/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0176 - acc: 0.9929 - val_loss: 0.1413 - val_ac
c: 0.7820
Epoch 426/700
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1/1 [==============================] - 0s 163ms/step - loss: 0.0185 - acc: 0.9786 - val_loss: 0.1456 - val_ac
c: 0.7640
Epoch 427/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0179 - acc: 0.9714 - val_loss: 0.1506 - val_ac
c: 0.7580
Epoch 428/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0189 - acc: 0.9786 - val_loss: 0.1507 - val_ac
c: 0.7600
Epoch 429/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0194 - acc: 0.9643 - val_loss: 0.1473 - val_ac
c: 0.7680
Epoch 430/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0176 - acc: 0.9857 - val_loss: 0.1421 - val_ac
c: 0.7680
Epoch 431/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0173 - acc: 0.9786 - val_loss: 0.1374 - val_ac
c: 0.7780
Epoch 432/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0215 - acc: 0.9500 - val_loss: 0.1346 - val_ac
c: 0.7800
Epoch 433/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0179 - acc: 0.9857 - val_loss: 0.1321 - val_ac
c: 0.7780
Epoch 434/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0175 - acc: 0.9786 - val_loss: 0.1327 - val_ac
c: 0.7780
Epoch 435/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0198 - acc: 0.9714 - val_loss: 0.1374 - val_ac
c: 0.7800
Epoch 436/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0171 - acc: 0.9857 - val_loss: 0.1437 - val_ac
c: 0.7680
Epoch 437/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0172 - acc: 1.0000 - val_loss: 0.1489 - val_ac
c: 0.7560
Epoch 438/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0202 - acc: 0.9714 - val_loss: 0.1523 - val_ac
c: 0.7480
Epoch 439/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0195 - acc: 0.9429 - val_loss: 0.1489 - val_ac
c: 0.7660
Epoch 440/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0180 - acc: 0.9714 - val_loss: 0.1477 - val_ac
c: 0.7620
Epoch 441/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0165 - acc: 0.9929 - val_loss: 0.1476 - val_ac
c: 0.7460
Epoch 442/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0175 - acc: 0.9786 - val_loss: 0.1476 - val_ac
c: 0.7380
Epoch 443/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0211 - acc: 0.9643 - val_loss: 0.1451 - val_ac
c: 0.7460
Epoch 444/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0172 - acc: 0.9929 - val_loss: 0.1415 - val_ac
c: 0.7560
Epoch 445/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0173 - acc: 1.0000 - val_loss: 0.1416 - val_ac
c: 0.7540
Epoch 446/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0169 - acc: 0.9714 - val_loss: 0.1417 - val_ac
c: 0.7600
Epoch 447/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0167 - acc: 0.9929 - val_loss: 0.1404 - val_ac
c: 0.7600
Epoch 448/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0196 - acc: 0.9643 - val_loss: 0.1362 - val_ac
c: 0.7620
Epoch 449/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0180 - acc: 0.9929 - val_loss: 0.1332 - val_ac
c: 0.7660
```

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Epoch 450/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0179 - acc: 0.9714 - val_loss: 0.1321 - val_ac
c: 0.7660
Epoch 451/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0194 - acc: 0.9786 - val_loss: 0.1326 - val_ac
c: 0.7820
Epoch 452/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0184 - acc: 0.9786 - val_loss: 0.1341 - val_ac
c: 0.7780
Epoch 453/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0179 - acc: 0.9857 - val_loss: 0.1384 - val_ac
c: 0.7720
Epoch 454/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0177 - acc: 0.9714 - val_loss: 0.1451 - val_ac
c: 0.7560
Epoch 455/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0192 - acc: 0.9571 - val_loss: 0.1554 - val_ac
c: 0.7440
Epoch 456/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0182 - acc: 0.9857 - val_loss: 0.1595 - val_ac
c: 0.7420
Epoch 457/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0167 - acc: 0.9857 - val_loss: 0.1580 - val_ac
c: 0.7460
Epoch 458/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0188 - acc: 0.9857 - val_loss: 0.1544 - val_ac
c: 0.7440
Epoch 459/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0198 - acc: 0.9643 - val_loss: 0.1462 - val_ac
c: 0.7540
Epoch 460/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0166 - acc: 0.9857 - val_loss: 0.1393 - val_ac
c: 0.7660
Epoch 461/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0181 - acc: 0.9714 - val_loss: 0.1366 - val_ac
c: 0.7600
Epoch 462/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0177 - acc: 0.9857 - val_loss: 0.1370 - val_ac
c: 0.7580
Epoch 463/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0174 - acc: 0.9786 - val_loss: 0.1390 - val_ac
c: 0.7540
Epoch 464/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0174 - acc: 0.9857 - val_loss: 0.1423 - val_ac
c: 0.7500
Epoch 465/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0181 - acc: 0.9786 - val_loss: 0.1466 - val_ac
c: 0.7440
Epoch 466/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0175 - acc: 0.9643 - val_loss: 0.1488 - val_ac
c: 0.7400
Epoch 467/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0174 - acc: 0.9643 - val_loss: 0.1488 - val_ac
c: 0.7520
Epoch 468/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0165 - acc: 0.9857 - val_loss: 0.1473 - val_ac
c: 0.7560
Epoch 469/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0173 - acc: 0.9643 - val_loss: 0.1468 - val_ac
c: 0.7640
Epoch 470/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0162 - acc: 0.9857 - val_loss: 0.1480 - val_ac
c: 0.7600
Epoch 471/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0194 - acc: 0.9714 - val_loss: 0.1488 - val_ac
c: 0.7580
Epoch 472/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0175 - acc: 0.9786 - val_loss: 0.1474 - val_ac
c: 0.7600
Epoch 473/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0170 - acc: 0.9786 - val_loss: 0.1435 - val_ac
```

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c: 0.7560
Epoch 474/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0176 - acc: 0.9786 - val_loss: 0.1396 - val_ac
c: 0.7620
Epoch 475/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0186 - acc: 0.9857 - val_loss: 0.1387 - val_ac
c: 0.7640
Epoch 476/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0183 - acc: 0.9857 - val_loss: 0.1430 - val_ac
c: 0.7620
Epoch 477/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0177 - acc: 0.9857 - val_loss: 0.1496 - val_ac
c: 0.7460
Epoch 478/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0182 - acc: 0.9857 - val_loss: 0.1511 - val_ac
c: 0.7500
Epoch 479/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0193 - acc: 0.9714 - val_loss: 0.1467 - val_ac
c: 0.7560
Epoch 480/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0184 - acc: 0.9643 - val_loss: 0.1416 - val_ac
c: 0.7620
Epoch 481/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0176 - acc: 0.9857 - val_loss: 0.1395 - val_ac
c: 0.7600
Epoch 482/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0195 - acc: 0.9571 - val_loss: 0.1383 - val_ac
c: 0.7680
Epoch 483/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0180 - acc: 0.9714 - val_loss: 0.1365 - val_ac
c: 0.7680
Epoch 484/700
1/1 [==============================] - 0s 180ms/step - loss: 0.0178 - acc: 0.9929 - val_loss: 0.1363 - val_ac
c: 0.7680
Epoch 485/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0172 - acc: 1.0000 - val_loss: 0.1385 - val_ac
c: 0.7660
Epoch 486/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0188 - acc: 0.9500 - val_loss: 0.1490 - val_ac
c: 0.7500
Epoch 487/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0174 - acc: 0.9714 - val_loss: 0.1577 - val_ac
c: 0.7460
Epoch 488/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0176 - acc: 0.9857 - val_loss: 0.1607 - val_ac
c: 0.7360
Epoch 489/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0186 - acc: 0.9857 - val_loss: 0.1569 - val_ac
c: 0.7380
Epoch 490/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0179 - acc: 0.9643 - val_loss: 0.1486 - val_ac
c: 0.7580
Epoch 491/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0180 - acc: 0.9857 - val_loss: 0.1388 - val_ac
c: 0.7740
Epoch 492/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0201 - acc: 0.9643 - val_loss: 0.1329 - val_ac
c: 0.7860
Epoch 493/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0162 - acc: 0.9857 - val_loss: 0.1327 - val_ac
c: 0.7860
Epoch 494/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0172 - acc: 0.9929 - val_loss: 0.1339 - val_ac
c: 0.7820
Epoch 495/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0199 - acc: 0.9571 - val_loss: 0.1317 - val_ac
c: 0.7880
Epoch 496/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0187 - acc: 0.9786 - val_loss: 0.1327 - val_ac
c: 0.7960
Epoch 497/700
```

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1/1 [==============================] - 0s 163ms/step - loss: 0.0168 - acc: 0.9929 - val_loss: 0.1389 - val_ac
c: 0.7800
Epoch 498/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0179 - acc: 0.9857 - val_loss: 0.1505 - val_ac
c: 0.7660
Epoch 499/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0182 - acc: 0.9786 - val_loss: 0.1600 - val_ac
c: 0.7440
Epoch 500/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0177 - acc: 0.9857 - val_loss: 0.1667 - val_ac
c: 0.7380
Epoch 501/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0186 - acc: 0.9643 - val_loss: 0.1639 - val_ac
c: 0.7400
Epoch 502/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0182 - acc: 0.9786 - val_loss: 0.1561 - val_ac
c: 0.7380
Epoch 503/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0162 - acc: 0.9857 - val_loss: 0.1471 - val_ac
c: 0.7500
Epoch 504/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0175 - acc: 0.9714 - val_loss: 0.1404 - val_ac
c: 0.7580
Epoch 505/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0180 - acc: 0.9786 - val_loss: 0.1362 - val_ac
c: 0.7740
Epoch 506/700
1/1 [==============================] - 0s 178ms/step - loss: 0.0165 - acc: 0.9929 - val_loss: 0.1344 - val_ac
c: 0.7720
Epoch 507/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0191 - acc: 0.9714 - val_loss: 0.1332 - val_ac
c: 0.7760
Epoch 508/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0166 - acc: 0.9857 - val_loss: 0.1332 - val_ac
c: 0.7840
Epoch 509/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0171 - acc: 0.9786 - val_loss: 0.1371 - val_ac
c: 0.7640
Epoch 510/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0186 - acc: 0.9643 - val_loss: 0.1436 - val_ac
c: 0.7600
Epoch 511/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0158 - acc: 0.9929 - val_loss: 0.1501 - val_ac
c: 0.7600
Epoch 512/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0178 - acc: 0.9857 - val_loss: 0.1533 - val_ac
c: 0.7600
Epoch 513/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0186 - acc: 0.9643 - val_loss: 0.1519 - val_ac
c: 0.7600
Epoch 514/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0171 - acc: 0.9714 - val_loss: 0.1447 - val_ac
c: 0.7620
Epoch 515/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0174 - acc: 0.9786 - val_loss: 0.1386 - val_ac
c: 0.7660
Epoch 516/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0174 - acc: 0.9714 - val_loss: 0.1340 - val_ac
c: 0.7800
Epoch 517/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0168 - acc: 0.9643 - val_loss: 0.1303 - val_ac
c: 0.7800
Epoch 518/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0168 - acc: 0.9857 - val_loss: 0.1274 - val_ac
c: 0.7880
Epoch 519/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0188 - acc: 0.9714 - val_loss: 0.1272 - val_ac
c: 0.7780
Epoch 520/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0159 - acc: 1.0000 - val_loss: 0.1296 - val_ac
c: 0.7760
```

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Epoch 521/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0173 - acc: 0.9714 - val_loss: 0.1341 - val_ac
c: 0.7600
Epoch 522/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0160 - acc: 0.9786 - val_loss: 0.1375 - val_ac
c: 0.7540
Epoch 523/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0167 - acc: 0.9786 - val_loss: 0.1421 - val_ac
c: 0.7500
Epoch 524/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0160 - acc: 0.9714 - val_loss: 0.1443 - val_ac
c: 0.7500
Epoch 525/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0147 - acc: 0.9929 - val_loss: 0.1453 - val_ac
c: 0.7500
Epoch 526/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0161 - acc: 1.0000 - val_loss: 0.1443 - val_ac
c: 0.7540
Epoch 527/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0162 - acc: 0.9714 - val_loss: 0.1401 - val_ac
c: 0.7680
Epoch 528/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0155 - acc: 1.0000 - val_loss: 0.1362 - val_ac
c: 0.7720
Epoch 529/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0154 - acc: 0.9857 - val_loss: 0.1332 - val_ac
c: 0.7860
Epoch 530/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0161 - acc: 0.9857 - val_loss: 0.1314 - val_ac
c: 0.7760
Epoch 531/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0160 - acc: 0.9714 - val_loss: 0.1302 - val_ac
c: 0.7860
Epoch 532/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0160 - acc: 0.9786 - val_loss: 0.1313 - val_ac
c: 0.7800
Epoch 533/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0156 - acc: 0.9929 - val_loss: 0.1331 - val_ac
c: 0.7740
Epoch 534/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0166 - acc: 0.9571 - val_loss: 0.1370 - val_ac
c: 0.7720
Epoch 535/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0164 - acc: 0.9857 - val_loss: 0.1387 - val_ac
c: 0.7640
Epoch 536/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0152 - acc: 0.9857 - val_loss: 0.1426 - val_ac
c: 0.7560
Epoch 537/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0172 - acc: 0.9857 - val_loss: 0.1453 - val_ac
c: 0.7620
Epoch 538/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0178 - acc: 0.9714 - val_loss: 0.1436 - val_ac
c: 0.7600
Epoch 539/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0175 - acc: 0.9714 - val_loss: 0.1383 - val_ac
c: 0.7700
Epoch 540/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0152 - acc: 1.0000 - val_loss: 0.1333 - val_ac
c: 0.7760
Epoch 541/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0181 - acc: 0.9643 - val_loss: 0.1326 - val_ac
c: 0.7800
Epoch 542/700
1/1 [==============================] - 0s 178ms/step - loss: 0.0150 - acc: 0.9929 - val_loss: 0.1332 - val_ac
c: 0.7780
Epoch 543/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0186 - acc: 0.9786 - val_loss: 0.1377 - val_ac
c: 0.7600
Epoch 544/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0177 - acc: 0.9857 - val_loss: 0.1419 - val_ac
```

```
c: 0.7640
Epoch 545/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0170 - acc: 0.9786 - val_loss: 0.1423 - val_ac
c: 0.7720
Epoch 546/700
1/1 [==============================] - 0s 182ms/step - loss: 0.0173 - acc: 0.9929 - val_loss: 0.1389 - val_ac
c: 0.7800
Epoch 547/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0192 - acc: 0.9643 - val_loss: 0.1351 - val_ac
c: 0.7900
Epoch 548/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0176 - acc: 0.9929 - val_loss: 0.1341 - val_ac
c: 0.7880
Epoch 549/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0162 - acc: 0.9857 - val_loss: 0.1338 - val_ac
c: 0.7860
Epoch 550/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0198 - acc: 0.9714 - val_loss: 0.1338 - val_ac
c: 0.7800
Epoch 551/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0169 - acc: 0.9786 - val_loss: 0.1350 - val_ac
c: 0.7800
Epoch 552/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0165 - acc: 0.9786 - val_loss: 0.1376 - val_ac
c: 0.7780
Epoch 553/700
1/1 [==============================] - 0s 178ms/step - loss: 0.0179 - acc: 0.9786 - val_loss: 0.1404 - val_ac
c: 0.7720
Epoch 554/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0172 - acc: 0.9786 - val_loss: 0.1399 - val_ac
c: 0.7680
Epoch 555/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0163 - acc: 0.9786 - val_loss: 0.1379 - val_ac
c: 0.7680
Epoch 556/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0177 - acc: 0.9786 - val_loss: 0.1369 - val_ac
c: 0.7620
Epoch 557/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0169 - acc: 0.9786 - val_loss: 0.1367 - val_ac
c: 0.7600
Epoch 558/700
1/1 [==============================] - 0s 190ms/step - loss: 0.0160 - acc: 0.9857 - val_loss: 0.1373 - val_ac
c: 0.7560
Epoch 559/700
1/1 [==============================] - 0s 178ms/step - loss: 0.0164 - acc: 0.9714 - val_loss: 0.1376 - val_ac
c: 0.7580
Epoch 560/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0155 - acc: 0.9857 - val_loss: 0.1374 - val_ac
c: 0.7620
Epoch 561/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0170 - acc: 0.9786 - val_loss: 0.1387 - val_ac
c: 0.7720
Epoch 562/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0155 - acc: 1.0000 - val_loss: 0.1398 - val_ac
c: 0.7780
Epoch 563/700
1/1 [==============================] - 0s 182ms/step - loss: 0.0166 - acc: 0.9786 - val_loss: 0.1412 - val_ac
c: 0.7680
Epoch 564/700
1/1 [==============================] - 0s 180ms/step - loss: 0.0160 - acc: 0.9857 - val_loss: 0.1389 - val_ac
c: 0.7720
Epoch 565/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0169 - acc: 0.9786 - val_loss: 0.1361 - val_ac
c: 0.7820
Epoch 566/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0146 - acc: 0.9786 - val_loss: 0.1343 - val_ac
c: 0.7800
Epoch 567/700
1/1 [==============================] - 0s 179ms/step - loss: 0.0157 - acc: 0.9714 - val_loss: 0.1341 - val_ac
c: 0.7860
Epoch 568/700
```

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1/1 [==============================] - 0s 165ms/step - loss: 0.0159 - acc: 0.9786 - val_loss: 0.1350 - val_ac
c: 0.7720
Epoch 569/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0148 - acc: 0.9857 - val_loss: 0.1355 - val_ac
c: 0.7720
Epoch 570/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0169 - acc: 0.9714 - val_loss: 0.1343 - val_ac
c: 0.7700
Epoch 571/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0170 - acc: 0.9643 - val_loss: 0.1345 - val_ac
c: 0.7740
Epoch 572/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0162 - acc: 0.9714 - val_loss: 0.1351 - val_ac
c: 0.7720
Epoch 573/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0164 - acc: 0.9857 - val_loss: 0.1352 - val_ac
c: 0.7740
Epoch 574/700
1/1 [==============================] - 0s 180ms/step - loss: 0.0166 - acc: 0.9571 - val_loss: 0.1355 - val_ac
c: 0.7820
Epoch 575/700
1/1 [==============================] - 0s 184ms/step - loss: 0.0160 - acc: 0.9929 - val_loss: 0.1368 - val_ac
c: 0.7820
Epoch 576/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0162 - acc: 0.9786 - val_loss: 0.1383 - val_ac
c: 0.7800
Epoch 577/700
1/1 [==============================] - 0s 177ms/step - loss: 0.0166 - acc: 0.9643 - val_loss: 0.1400 - val_ac
c: 0.7700
Epoch 578/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0167 - acc: 0.9857 - val_loss: 0.1403 - val_ac
c: 0.7740
Epoch 579/700
1/1 [==============================] - 0s 159ms/step - loss: 0.0145 - acc: 1.0000 - val_loss: 0.1399 - val_ac
c: 0.7680
Epoch 580/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0159 - acc: 0.9857 - val_loss: 0.1385 - val_ac
c: 0.7680
Epoch 581/700
1/1 [==============================] - 0s 182ms/step - loss: 0.0140 - acc: 1.0000 - val_loss: 0.1389 - val_ac
c: 0.7680
Epoch 582/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0174 - acc: 0.9714 - val_loss: 0.1379 - val_ac
c: 0.7760
Epoch 583/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0162 - acc: 0.9714 - val_loss: 0.1414 - val_ac
c: 0.7840
Epoch 584/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0164 - acc: 0.9929 - val_loss: 0.1445 - val_ac
c: 0.7820
Epoch 585/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0169 - acc: 0.9643 - val_loss: 0.1465 - val_ac
c: 0.7700
Epoch 586/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0183 - acc: 0.9571 - val_loss: 0.1492 - val_ac
c: 0.7680
Epoch 587/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0153 - acc: 0.9929 - val_loss: 0.1487 - val_ac
c: 0.7600
Epoch 588/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0156 - acc: 0.9929 - val_loss: 0.1454 - val_ac
c: 0.7580
Epoch 589/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0154 - acc: 0.9857 - val_loss: 0.1410 - val_ac
c: 0.7620
Epoch 590/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0157 - acc: 0.9929 - val_loss: 0.1374 - val_ac
c: 0.7620
Epoch 591/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0174 - acc: 0.9786 - val_loss: 0.1358 - val_ac
c: 0.7700
```

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Epoch 592/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0167 - acc: 0.9786 - val_loss: 0.1370 - val_ac
c: 0.7740
Epoch 593/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0160 - acc: 0.9857 - val_loss: 0.1407 - val_ac
c: 0.7700
Epoch 594/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0161 - acc: 0.9857 - val_loss: 0.1441 - val_ac
c: 0.7640
Epoch 595/700
1/1 [==============================] - 0s 177ms/step - loss: 0.0162 - acc: 0.9786 - val_loss: 0.1458 - val_ac
c: 0.7600
Epoch 596/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0177 - acc: 0.9571 - val_loss: 0.1446 - val_ac
c: 0.7780
Epoch 597/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0161 - acc: 0.9786 - val_loss: 0.1429 - val_ac
c: 0.7820
Epoch 598/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0173 - acc: 0.9643 - val_loss: 0.1414 - val_ac
c: 0.7680
Epoch 599/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0182 - acc: 0.9929 - val_loss: 0.1392 - val_ac
c: 0.7740
Epoch 600/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0166 - acc: 0.9786 - val_loss: 0.1348 - val_ac
c: 0.7820
Epoch 601/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0164 - acc: 0.9929 - val_loss: 0.1322 - val_ac
c: 0.7920
Epoch 602/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0154 - acc: 0.9786 - val_loss: 0.1332 - val_ac
c: 0.7920
Epoch 603/700
1/1 [==============================] - 0s 180ms/step - loss: 0.0164 - acc: 0.9786 - val_loss: 0.1376 - val_ac
c: 0.7880
Epoch 604/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0168 - acc: 0.9714 - val_loss: 0.1416 - val_ac
c: 0.7780
Epoch 605/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0149 - acc: 1.0000 - val_loss: 0.1425 - val_ac
c: 0.7820
Epoch 606/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0152 - acc: 0.9857 - val_loss: 0.1428 - val_ac
c: 0.7820
Epoch 607/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0155 - acc: 0.9857 - val_loss: 0.1426 - val_ac
c: 0.7740
Epoch 608/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0145 - acc: 1.0000 - val_loss: 0.1435 - val_ac
c: 0.7740
Epoch 609/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0152 - acc: 0.9929 - val_loss: 0.1452 - val_ac
c: 0.7700
Epoch 610/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0168 - acc: 0.9500 - val_loss: 0.1454 - val_ac
c: 0.7680
Epoch 611/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0175 - acc: 0.9786 - val_loss: 0.1400 - val_ac
c: 0.7740
Epoch 612/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0159 - acc: 0.9857 - val_loss: 0.1341 - val_ac
c: 0.7900
Epoch 613/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0160 - acc: 0.9714 - val_loss: 0.1329 - val_ac
c: 0.7860
Epoch 614/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0169 - acc: 0.9786 - val_loss: 0.1346 - val_ac
c: 0.7760
Epoch 615/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0164 - acc: 0.9714 - val_loss: 0.1385 - val_ac
```

```
c: 0.7700
Epoch 616/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0164 - acc: 0.9786 - val_loss: 0.1413 - val_ac
c: 0.7620
Epoch 617/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0177 - acc: 0.9643 - val_loss: 0.1429 - val_ac
c: 0.7560
Epoch 618/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0178 - acc: 0.9714 - val_loss: 0.1425 - val_ac
c: 0.7580
Epoch 619/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0152 - acc: 0.9857 - val_loss: 0.1440 - val_ac
c: 0.7540
Epoch 620/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0161 - acc: 0.9857 - val_loss: 0.1456 - val_ac
c: 0.7440
Epoch 621/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0169 - acc: 0.9643 - val_loss: 0.1437 - val_ac
c: 0.7560
Epoch 622/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0169 - acc: 0.9571 - val_loss: 0.1426 - val_ac
c: 0.7620
Epoch 623/700
1/1 [==============================] - 0s 179ms/step - loss: 0.0163 - acc: 0.9786 - val_loss: 0.1413 - val_ac
c: 0.7740
Epoch 624/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0161 - acc: 0.9857 - val_loss: 0.1426 - val_ac
c: 0.7840
Epoch 625/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0146 - acc: 0.9929 - val_loss: 0.1426 - val_ac
c: 0.7760
Epoch 626/700
1/1 [==============================] - 0s 180ms/step - loss: 0.0165 - acc: 0.9857 - val_loss: 0.1400 - val_ac
c: 0.7800
Epoch 627/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0156 - acc: 0.9786 - val_loss: 0.1365 - val_ac
c: 0.7880
Epoch 628/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0163 - acc: 0.9714 - val_loss: 0.1340 - val_ac
c: 0.7940
Epoch 629/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0170 - acc: 0.9714 - val_loss: 0.1345 - val_ac
c: 0.7920
Epoch 630/700
1/1 [==============================] - 0s 184ms/step - loss: 0.0188 - acc: 0.9643 - val_loss: 0.1378 - val_ac
c: 0.7780
Epoch 631/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0152 - acc: 0.9786 - val_loss: 0.1440 - val_ac
c: 0.7560
Epoch 632/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0165 - acc: 0.9929 - val_loss: 0.1496 - val_ac
c: 0.7400
Epoch 633/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0156 - acc: 0.9714 - val_loss: 0.1555 - val_ac
c: 0.7400
Epoch 634/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0184 - acc: 0.9643 - val_loss: 0.1570 - val_ac
c: 0.7360
Epoch 635/700
1/1 [==============================] - 0s 185ms/step - loss: 0.0170 - acc: 0.9786 - val_loss: 0.1515 - val_ac
c: 0.7520
Epoch 636/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0150 - acc: 0.9929 - val_loss: 0.1454 - val_ac
c: 0.7660
Epoch 637/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0158 - acc: 0.9929 - val_loss: 0.1400 - val_ac
c: 0.7720
Epoch 638/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0163 - acc: 0.9786 - val_loss: 0.1387 - val_ac
c: 0.7860
Epoch 639/700
```

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1/1 [==============================] - 0s 169ms/step - loss: 0.0153 - acc: 0.9929 - val_loss: 0.1393 - val_ac
c: 0.7820
Epoch 640/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0158 - acc: 0.9929 - val_loss: 0.1416 - val_ac
c: 0.7700
Epoch 641/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0161 - acc: 0.9857 - val_loss: 0.1473 - val_ac
c: 0.7540
Epoch 642/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0150 - acc: 0.9929 - val_loss: 0.1512 - val_ac
c: 0.7560
Epoch 643/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0163 - acc: 0.9714 - val_loss: 0.1515 - val_ac
c: 0.7520
Epoch 644/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0148 - acc: 1.0000 - val_loss: 0.1504 - val_ac
c: 0.7520
Epoch 645/700
1/1 [==============================] - 0s 179ms/step - loss: 0.0185 - acc: 0.9571 - val_loss: 0.1470 - val_ac
c: 0.7500
Epoch 646/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0170 - acc: 0.9786 - val_loss: 0.1420 - val_ac
c: 0.7600
Epoch 647/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0164 - acc: 0.9786 - val_loss: 0.1372 - val_ac
c: 0.7700
Epoch 648/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0153 - acc: 0.9786 - val_loss: 0.1355 - val_ac
c: 0.7740
Epoch 649/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0154 - acc: 1.0000 - val_loss: 0.1362 - val_ac
c: 0.7740
Epoch 650/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0147 - acc: 0.9929 - val_loss: 0.1365 - val_ac
c: 0.7740
Epoch 651/700
1/1 [==============================] - 0s 185ms/step - loss: 0.0171 - acc: 0.9786 - val_loss: 0.1395 - val_ac
c: 0.7780
Epoch 652/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0158 - acc: 0.9786 - val_loss: 0.1437 - val_ac
c: 0.7640
Epoch 653/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0141 - acc: 1.0000 - val_loss: 0.1489 - val_ac
c: 0.7580
Epoch 654/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0159 - acc: 0.9714 - val_loss: 0.1510 - val_ac
c: 0.7540
Epoch 655/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0172 - acc: 0.9714 - val_loss: 0.1505 - val_ac
c: 0.7500
Epoch 656/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0154 - acc: 0.9857 - val_loss: 0.1477 - val_ac
c: 0.7500
Epoch 657/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0165 - acc: 0.9571 - val_loss: 0.1444 - val_ac
c: 0.7620
Epoch 658/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0149 - acc: 0.9929 - val_loss: 0.1425 - val_ac
c: 0.7620
Epoch 659/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0170 - acc: 0.9571 - val_loss: 0.1403 - val_ac
c: 0.7760
Epoch 660/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0150 - acc: 0.9857 - val_loss: 0.1378 - val_ac
c: 0.7780
Epoch 661/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0162 - acc: 1.0000 - val_loss: 0.1362 - val_ac
c: 0.7740
Epoch 662/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0159 - acc: 0.9857 - val_loss: 0.1360 - val_ac
c: 0.7800
```

```
Epoch 663/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0165 - acc: 0.9786 - val_loss: 0.1372 - val_ac
c: 0.7860
Epoch 664/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0144 - acc: 0.9929 - val_loss: 0.1408 - val_ac
c: 0.7780
Epoch 665/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0176 - acc: 0.9500 - val_loss: 0.1431 - val_ac
c: 0.7740
Epoch 666/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0155 - acc: 0.9929 - val_loss: 0.1427 - val_ac
c: 0.7720
Epoch 667/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0181 - acc: 0.9429 - val_loss: 0.1430 - val_ac
c: 0.7700
Epoch 668/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0167 - acc: 0.9643 - val_loss: 0.1447 - val_ac
c: 0.7540
Epoch 669/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0148 - acc: 0.9857 - val_loss: 0.1455 - val_ac
c: 0.7520
Epoch 670/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0165 - acc: 0.9786 - val_loss: 0.1434 - val_ac
c: 0.7700
Epoch 671/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0148 - acc: 0.9929 - val_loss: 0.1395 - val_ac
c: 0.7840
Epoch 672/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0162 - acc: 0.9714 - val_loss: 0.1366 - val_ac
c: 0.7860
Epoch 673/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0174 - acc: 0.9786 - val_loss: 0.1337 - val_ac
c: 0.7940
Epoch 674/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0169 - acc: 0.9714 - val_loss: 0.1298 - val_ac
c: 0.7980
Epoch 675/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0154 - acc: 1.0000 - val_loss: 0.1281 - val_ac
c: 0.7940
Epoch 676/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0148 - acc: 0.9857 - val_loss: 0.1295 - val_ac
c: 0.7920
Epoch 677/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0159 - acc: 0.9714 - val_loss: 0.1323 - val_ac
c: 0.7820
Epoch 678/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0169 - acc: 0.9714 - val_loss: 0.1392 - val_ac
c: 0.7700
Epoch 679/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0145 - acc: 0.9929 - val_loss: 0.1477 - val_ac
c: 0.7620
Epoch 680/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0165 - acc: 0.9786 - val_loss: 0.1557 - val_ac
c: 0.7560
Epoch 681/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0160 - acc: 0.9929 - val_loss: 0.1613 - val_ac
c: 0.7600
Epoch 682/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0179 - acc: 0.9643 - val_loss: 0.1551 - val_ac
c: 0.7580
Epoch 683/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0168 - acc: 0.9714 - val_loss: 0.1491 - val_ac
c: 0.7580
Epoch 684/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0155 - acc: 0.9714 - val_loss: 0.1471 - val_ac
c: 0.7560
Epoch 685/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0156 - acc: 0.9857 - val_loss: 0.1436 - val_ac
c: 0.7560
Epoch 686/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0151 - acc: 0.9857 - val_loss: 0.1416 - val_ac
```

```
c: 0.7580
Epoch 687/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0133 - acc: 1.0000 - val_loss: 0.1416 - val_ac
c: 0.7660
Epoch 688/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0136 - acc: 0.9929 - val_loss: 0.1415 - val_ac
c: 0.7660
Epoch 689/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0192 - acc: 0.9500 - val_loss: 0.1416 - val_ac
c: 0.7740
Epoch 690/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0161 - acc: 0.9857 - val_loss: 0.1393 - val_ac
c: 0.7760
Epoch 691/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0182 - acc: 0.9786 - val_loss: 0.1361 - val_ac
c: 0.7800
Epoch 692/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0184 - acc: 0.9571 - val_loss: 0.1359 - val_ac
c: 0.7760
Epoch 693/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0152 - acc: 0.9929 - val_loss: 0.1428 - val_ac
c: 0.7700
Epoch 694/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0174 - acc: 0.9714 - val_loss: 0.1500 - val_ac
c: 0.7520
Epoch 695/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0157 - acc: 0.9857 - val_loss: 0.1549 - val_ac
c: 0.7480
Epoch 696/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0165 - acc: 0.9786 - val_loss: 0.1524 - val_ac
c: 0.7560
Epoch 697/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0156 - acc: 1.0000 - val_loss: 0.1459 - val_ac
c: 0.7800
Epoch 698/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0152 - acc: 1.0000 - val_loss: 0.1437 - val_ac
c: 0.7720
Epoch 699/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0151 - acc: 0.9857 - val_loss: 0.1432 - val_ac
c: 0.7780
Epoch 700/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0157 - acc: 0.9786 - val_loss: 0.1430 - val_ac
c: 0.7800
```

Out[ ]:
```
<tensorflow.python.keras.callbacks.History at 0x232438d0f48>
```

In [ ]:
```
# Evaluate model
X_te = X[test_mask]
A_te = A[test_mask,:][:,test_mask]
y_te = labels_encoded[test_mask]

y_pred = model.predict([X_te, A_te], batch_size=N)
report = classification_report(np.argmax(y_te,axis=1), np.argmax(y_pred,axis=1), target_names=classes)
print('GCN Classification Report: \n {}'.format(report))
```

```
GCN Classification Report:
                        precision    recall  f1-score   support

            Case_Based       0.55      0.81      0.66       114
    Genetic_Algorithms       0.84      0.86      0.85       156
       Neural_Networks       0.83      0.64      0.73       290
 Probabilistic_Methods       0.81      0.67      0.73       172
Reinforcement_Learning       0.56      0.81      0.66        85
         Rule_Learning       0.66      0.68      0.67        60
                Theory       0.56      0.56      0.56       123

              accuracy                           0.71      1000
             macro avg       0.69      0.72      0.69      1000
          weighted avg       0.73      0.71      0.71      1000
```

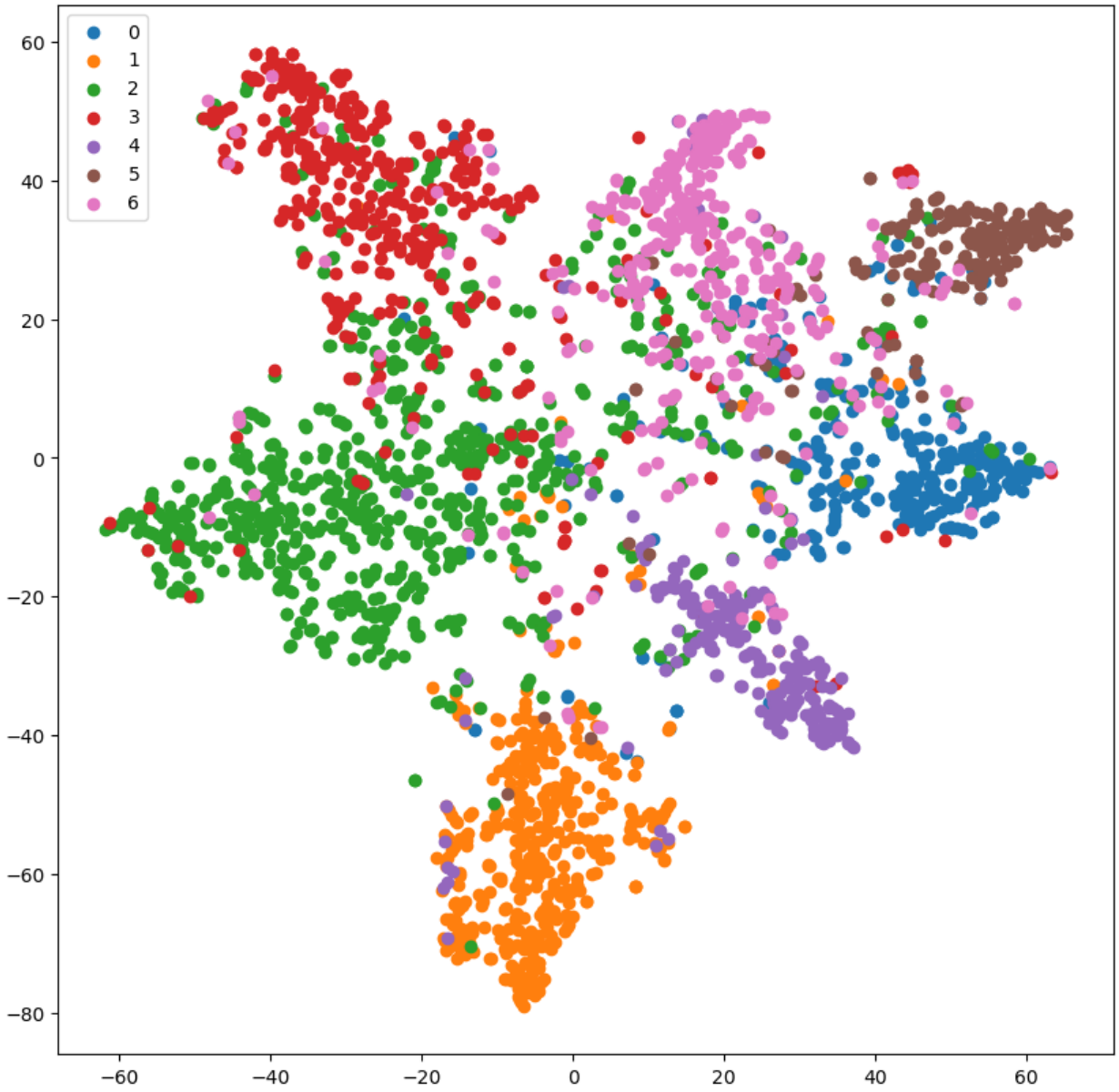
Get hidden layer representation for GCN

In [ ]:
```
layer_outputs = [layer.output for layer in model.layers]
activation_model = Model(inputs=model.input, outputs=layer_outputs)
activations = activation_model.predict([X,A],batch_size=N)

#Get t-SNE Representation
#get the hidden layer representation after the first GCN layer
x_tsne = TSNE(n_components=2).fit_transform(activations[3])
```

In [ ]:
```
def plot_tSNE(labels_encoded,x_tsne):
    color_map = np.argmax(labels_encoded, axis=1)
    plt.figure(figsize=(10,10))
    for cl in range(num_classes):
        indices = np.where(color_map==cl)
        indices = indices[0]
        plt.scatter(x_tsne[indices,0], x_tsne[indices, 1], label=cl)
    plt.legend()
    plt.show()

plot_tSNE(labels_encoded,x_tsne)
```



Comparison to Fully-Connected Neural Networks

Building and Training FNN

In [ ]:
```
es_patience = 350
optimizer = Adam(lr=1e-2)
l2_reg = 5e-4
epochs = 700

#Compare with FNN
#Construct the model
model_fnn = Sequential()
model_fnn.add(Dense(
                    128,
                    input_dim=X.shape[1],
                    activation=tf.nn.relu,
                    kernel_regularizer=tf.keras.regularizers.l2(l2_reg))
             )
model_fnn.add(Dropout(0.5))
model_fnn.add(Dense(256, activation=tf.nn.relu))
model_fnn.add(Dropout(0.5))
model_fnn.add(Dense(num_classes, activation=tf.keras.activations.softmax))


model_fnn.compile(optimizer=optimizer,
              loss='categorical_crossentropy',
              weighted_metrics=['acc'])


#define TensorBoard
tbCallBack_FNN = TensorBoard(
    log_dir='./Tensorboard_FNN_cora',
)

#Train model
validation_data_fnn = (X, labels_encoded, val_mask)
model_fnn.fit(
                X,labels_encoded,
                sample_weight=train_mask,
                epochs=epochs,
                batch_size=N,
                validation_data=validation_data_fnn,
                shuffle=False,
                callbacks=[
                  EarlyStopping(patience=es_patience,  restore_best_weights=True),
                  tbCallBack_FNN
          ])
```

```
Epoch 1/700
1/1 [==============================] - 0s 251ms/step - loss: 0.2181 - acc: 0.1571 - val_loss: 0.4327 - val_ac
c: 0.2900
Epoch 2/700
1/1 [==============================] - ETA: 0s - loss: 0.1741 - acc: 0.3500WARNING:tensorflow:Method (on_trai
n_batch_end) is slow compared to the batch update (0.147035). Check your callbacks.
1/1 [==============================] - 0s 164ms/step - loss: 0.1741 - acc: 0.3500 - val_loss: 0.3965 - val_ac
c: 0.4220
Epoch 3/700
1/1 [==============================] - 0s 175ms/step - loss: 0.1393 - acc: 0.5714 - val_loss: 0.3635 - val_ac
c: 0.5080
Epoch 4/700
1/1 [==============================] - 0s 168ms/step - loss: 0.1111 - acc: 0.6929 - val_loss: 0.3309 - val_ac
c: 0.5540
Epoch 5/700
1/1 [==============================] - 0s 182ms/step - loss: 0.0869 - acc: 0.8000 - val_loss: 0.3003 - val_ac
c: 0.5680
Epoch 6/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0661 - acc: 0.8357 - val_loss: 0.2725 - val_ac
c: 0.5920
Epoch 7/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0517 - acc: 0.9286 - val_loss: 0.2621 - val_ac
c: 0.5700
Epoch 8/700
1/1 [==============================] - 0s 195ms/step - loss: 0.0463 - acc: 0.9214 - val_loss: 0.2722 - val_ac
c: 0.5640
Epoch 9/700
1/1 [==============================] - 0s 192ms/step - loss: 0.0425 - acc: 0.9857 - val_loss: 0.2890 - val_ac
c: 0.5500
Epoch 10/700
1/1 [==============================] - 0s 240ms/step - loss: 0.0428 - acc: 0.9643 - val_loss: 0.3207 - val_ac
c: 0.5320
Epoch 11/700
1/1 [==============================] - 0s 224ms/step - loss: 0.0434 - acc: 0.9857 - val_loss: 0.3539 - val_ac
c: 0.5320
Epoch 12/700
1/1 [==============================] - 0s 215ms/step - loss: 0.0411 - acc: 1.0000 - val_loss: 0.3873 - val_ac
c: 0.5220
Epoch 13/700
1/1 [==============================] - 0s 341ms/step - loss: 0.0413 - acc: 0.9786 - val_loss: 0.4106 - val_ac
c: 0.5280
Epoch 14/700
1/1 [==============================] - 0s 267ms/step - loss: 0.0402 - acc: 0.9857 - val_loss: 0.4279 - val_ac
c: 0.5200
Epoch 15/700
1/1 [==============================] - 0s 229ms/step - loss: 0.0388 - acc: 0.9857 - val_loss: 0.4215 - val_ac
c: 0.5160
Epoch 16/700
1/1 [==============================] - 0s 227ms/step - loss: 0.0351 - acc: 0.9929 - val_loss: 0.4219 - val_ac
c: 0.5260
Epoch 17/700
1/1 [==============================] - 0s 217ms/step - loss: 0.0322 - acc: 0.9857 - val_loss: 0.4193 - val_ac
c: 0.5200
Epoch 18/700
1/1 [==============================] - 0s 213ms/step - loss: 0.0297 - acc: 0.9857 - val_loss: 0.4108 - val_ac
c: 0.5420
Epoch 19/700
1/1 [==============================] - 0s 221ms/step - loss: 0.0272 - acc: 0.9857 - val_loss: 0.4067 - val_ac
c: 0.5340
Epoch 20/700
1/1 [==============================] - 0s 223ms/step - loss: 0.0239 - acc: 1.0000 - val_loss: 0.4037 - val_ac
c: 0.5200
Epoch 21/700
1/1 [==============================] - 0s 294ms/step - loss: 0.0264 - acc: 0.9786 - val_loss: 0.4067 - val_ac
c: 0.5220
Epoch 22/700
1/1 [==============================] - 0s 231ms/step - loss: 0.0217 - acc: 0.9786 - val_loss: 0.4003 - val_ac
c: 0.5000
Epoch 23/700
1/1 [==============================] - 0s 229ms/step - loss: 0.0205 - acc: 0.9857 - val_loss: 0.3982 - val_ac
c: 0.4940
```

```
Epoch 24/700
1/1 [==============================] - 0s 332ms/step - loss: 0.0225 - acc: 0.9714 - val_loss: 0.4046 - val_ac
c: 0.4800
Epoch 25/700
1/1 [==============================] - 0s 261ms/step - loss: 0.0207 - acc: 0.9714 - val_loss: 0.4157 - val_ac
c: 0.4580
Epoch 26/700
1/1 [==============================] - 0s 225ms/step - loss: 0.0197 - acc: 0.9857 - val_loss: 0.4049 - val_ac
c: 0.4700
Epoch 27/700
1/1 [==============================] - 0s 232ms/step - loss: 0.0181 - acc: 0.9929 - val_loss: 0.3853 - val_ac
c: 0.4820
Epoch 28/700
1/1 [==============================] - 0s 269ms/step - loss: 0.0186 - acc: 0.9929 - val_loss: 0.3667 - val_ac
c: 0.5200
Epoch 29/700
1/1 [==============================] - 0s 247ms/step - loss: 0.0200 - acc: 0.9857 - val_loss: 0.3484 - val_ac
c: 0.5300
Epoch 30/700
1/1 [==============================] - 0s 250ms/step - loss: 0.0225 - acc: 0.9643 - val_loss: 0.3395 - val_ac
c: 0.5160
Epoch 31/700
1/1 [==============================] - 0s 225ms/step - loss: 0.0207 - acc: 0.9714 - val_loss: 0.3341 - val_ac
c: 0.5120
Epoch 32/700
1/1 [==============================] - 0s 218ms/step - loss: 0.0223 - acc: 0.9643 - val_loss: 0.3311 - val_ac
c: 0.5060
Epoch 33/700
1/1 [==============================] - 0s 220ms/step - loss: 0.0191 - acc: 0.9857 - val_loss: 0.3354 - val_ac
c: 0.5160
Epoch 34/700
1/1 [==============================] - 0s 294ms/step - loss: 0.0205 - acc: 0.9929 - val_loss: 0.3422 - val_ac
c: 0.5120
Epoch 35/700
1/1 [==============================] - 0s 271ms/step - loss: 0.0201 - acc: 0.9929 - val_loss: 0.3487 - val_ac
c: 0.5220
Epoch 36/700
1/1 [==============================] - 0s 222ms/step - loss: 0.0202 - acc: 0.9929 - val_loss: 0.3544 - val_ac
c: 0.5260
Epoch 37/700
1/1 [==============================] - 0s 224ms/step - loss: 0.0207 - acc: 0.9929 - val_loss: 0.3563 - val_ac
c: 0.5200
Epoch 38/700
1/1 [==============================] - 0s 204ms/step - loss: 0.0214 - acc: 1.0000 - val_loss: 0.3561 - val_ac
c: 0.5160
Epoch 39/700
1/1 [==============================] - 0s 206ms/step - loss: 0.0230 - acc: 0.9857 - val_loss: 0.3440 - val_ac
c: 0.5120
Epoch 40/700
1/1 [==============================] - 0s 211ms/step - loss: 0.0222 - acc: 0.9929 - val_loss: 0.3378 - val_ac
c: 0.5300
Epoch 41/700
1/1 [==============================] - 0s 216ms/step - loss: 0.0208 - acc: 1.0000 - val_loss: 0.3359 - val_ac
c: 0.5400
Epoch 42/700
1/1 [==============================] - 0s 189ms/step - loss: 0.0210 - acc: 1.0000 - val_loss: 0.3388 - val_ac
c: 0.5320
Epoch 43/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0212 - acc: 0.9929 - val_loss: 0.3421 - val_ac
c: 0.5300
Epoch 44/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0208 - acc: 0.9929 - val_loss: 0.3469 - val_ac
c: 0.5260
Epoch 45/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0199 - acc: 1.0000 - val_loss: 0.3494 - val_ac
c: 0.5140
Epoch 46/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0207 - acc: 0.9929 - val_loss: 0.3541 - val_ac
c: 0.5040
Epoch 47/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0213 - acc: 0.9929 - val_loss: 0.3584 - val_ac
```

```
c: 0.4880
Epoch 48/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0186 - acc: 1.0000 - val_loss: 0.3648 - val_ac
c: 0.4880
Epoch 49/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0184 - acc: 0.9929 - val_loss: 0.3655 - val_ac
c: 0.4940
Epoch 50/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0180 - acc: 1.0000 - val_loss: 0.3593 - val_ac
c: 0.4940
Epoch 51/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0191 - acc: 0.9786 - val_loss: 0.3496 - val_ac
c: 0.5080
Epoch 52/700
1/1 [==============================] - 0s 194ms/step - loss: 0.0174 - acc: 1.0000 - val_loss: 0.3424 - val_ac
c: 0.5220
Epoch 53/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0167 - acc: 0.9929 - val_loss: 0.3376 - val_ac
c: 0.5320
Epoch 54/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0185 - acc: 0.9786 - val_loss: 0.3284 - val_ac
c: 0.5360
Epoch 55/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0172 - acc: 0.9786 - val_loss: 0.3239 - val_ac
c: 0.5500
Epoch 56/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0169 - acc: 0.9786 - val_loss: 0.3230 - val_ac
c: 0.5540
Epoch 57/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0154 - acc: 1.0000 - val_loss: 0.3320 - val_ac
c: 0.5480
Epoch 58/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0155 - acc: 1.0000 - val_loss: 0.3427 - val_ac
c: 0.5200
Epoch 59/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0156 - acc: 0.9929 - val_loss: 0.3578 - val_ac
c: 0.5240
Epoch 60/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0165 - acc: 0.9929 - val_loss: 0.3633 - val_ac
c: 0.5300
Epoch 61/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0195 - acc: 0.9643 - val_loss: 0.3579 - val_ac
c: 0.5100
Epoch 62/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0177 - acc: 0.9857 - val_loss: 0.3439 - val_ac
c: 0.5080
Epoch 63/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0176 - acc: 0.9786 - val_loss: 0.3415 - val_ac
c: 0.5240
Epoch 64/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0172 - acc: 0.9786 - val_loss: 0.3493 - val_ac
c: 0.5160
Epoch 65/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0165 - acc: 1.0000 - val_loss: 0.3575 - val_ac
c: 0.5240
Epoch 66/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0186 - acc: 0.9857 - val_loss: 0.3519 - val_ac
c: 0.5220
Epoch 67/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0200 - acc: 0.9643 - val_loss: 0.3500 - val_ac
c: 0.5240
Epoch 68/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0176 - acc: 1.0000 - val_loss: 0.3543 - val_ac
c: 0.5120
Epoch 69/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0173 - acc: 1.0000 - val_loss: 0.3639 - val_ac
c: 0.5080
Epoch 70/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0187 - acc: 0.9857 - val_loss: 0.3748 - val_ac
c: 0.5060
Epoch 71/700
```

```
1/1 [==============================] - 0s 165ms/step - loss: 0.0204 - acc: 0.9643 - val_loss: 0.3719 - val_ac
c: 0.5120
Epoch 72/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0205 - acc: 0.9857 - val_loss: 0.3664 - val_ac
c: 0.5320
Epoch 73/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0202 - acc: 0.9929 - val_loss: 0.3675 - val_ac
c: 0.5380
Epoch 74/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0194 - acc: 0.9929 - val_loss: 0.3725 - val_ac
c: 0.5360
Epoch 75/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0231 - acc: 0.9714 - val_loss: 0.3816 - val_ac
c: 0.5340
Epoch 76/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0224 - acc: 0.9786 - val_loss: 0.3935 - val_ac
c: 0.5280
Epoch 77/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0219 - acc: 0.9857 - val_loss: 0.4065 - val_ac
c: 0.5240
Epoch 78/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0207 - acc: 0.9929 - val_loss: 0.4186 - val_ac
c: 0.5100
Epoch 79/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0220 - acc: 0.9929 - val_loss: 0.4259 - val_ac
c: 0.4980
Epoch 80/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0223 - acc: 0.9857 - val_loss: 0.4244 - val_ac
c: 0.5120
Epoch 81/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0226 - acc: 0.9786 - val_loss: 0.4116 - val_ac
c: 0.5100
Epoch 82/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0250 - acc: 0.9643 - val_loss: 0.4104 - val_ac
c: 0.5140
Epoch 83/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0227 - acc: 0.9857 - val_loss: 0.4204 - val_ac
c: 0.5120
Epoch 84/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0226 - acc: 0.9929 - val_loss: 0.4414 - val_ac
c: 0.4840
Epoch 85/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0219 - acc: 0.9929 - val_loss: 0.4549 - val_ac
c: 0.4700
Epoch 86/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0279 - acc: 0.9714 - val_loss: 0.4802 - val_ac
c: 0.4700
Epoch 87/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0254 - acc: 0.9786 - val_loss: 0.4762 - val_ac
c: 0.4720
Epoch 88/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0266 - acc: 0.9714 - val_loss: 0.4487 - val_ac
c: 0.4960
Epoch 89/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0253 - acc: 0.9714 - val_loss: 0.4296 - val_ac
c: 0.5260
Epoch 90/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0242 - acc: 0.9857 - val_loss: 0.4081 - val_ac
c: 0.5420
Epoch 91/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0234 - acc: 1.0000 - val_loss: 0.3878 - val_ac
c: 0.5500
Epoch 92/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0253 - acc: 0.9857 - val_loss: 0.3782 - val_ac
c: 0.5460
Epoch 93/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0247 - acc: 0.9857 - val_loss: 0.3770 - val_ac
c: 0.5440
Epoch 94/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0273 - acc: 0.9714 - val_loss: 0.3796 - val_ac
c: 0.5440
```

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Epoch 95/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0272 - acc: 0.9786 - val_loss: 0.3845 - val_ac
c: 0.5360
Epoch 96/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0248 - acc: 1.0000 - val_loss: 0.3894 - val_ac
c: 0.5260
Epoch 97/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0266 - acc: 0.9929 - val_loss: 0.3954 - val_ac
c: 0.5160
Epoch 98/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0286 - acc: 0.9714 - val_loss: 0.3956 - val_ac
c: 0.5160
Epoch 99/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0254 - acc: 1.0000 - val_loss: 0.4005 - val_ac
c: 0.4940
Epoch 100/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0295 - acc: 0.9857 - val_loss: 0.4025 - val_ac
c: 0.4900
Epoch 101/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0268 - acc: 0.9857 - val_loss: 0.4021 - val_ac
c: 0.4840
Epoch 102/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0280 - acc: 0.9857 - val_loss: 0.4005 - val_ac
c: 0.4800
Epoch 103/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0262 - acc: 1.0000 - val_loss: 0.4012 - val_ac
c: 0.4700
Epoch 104/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0286 - acc: 0.9857 - val_loss: 0.3984 - val_ac
c: 0.4640
Epoch 105/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0301 - acc: 0.9571 - val_loss: 0.3970 - val_ac
c: 0.4600
Epoch 106/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0280 - acc: 0.9857 - val_loss: 0.3962 - val_ac
c: 0.4720
Epoch 107/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0278 - acc: 0.9786 - val_loss: 0.3930 - val_ac
c: 0.4820
Epoch 108/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0290 - acc: 0.9714 - val_loss: 0.3988 - val_ac
c: 0.4700
Epoch 109/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0267 - acc: 0.9929 - val_loss: 0.4130 - val_ac
c: 0.4780
Epoch 110/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0270 - acc: 0.9857 - val_loss: 0.4268 - val_ac
c: 0.4620
Epoch 111/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0262 - acc: 1.0000 - val_loss: 0.4414 - val_ac
c: 0.4680
Epoch 112/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0284 - acc: 0.9857 - val_loss: 0.4544 - val_ac
c: 0.4460
Epoch 113/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0265 - acc: 0.9857 - val_loss: 0.4706 - val_ac
c: 0.4260
Epoch 114/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0310 - acc: 0.9500 - val_loss: 0.4634 - val_ac
c: 0.4360
Epoch 115/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0317 - acc: 0.9500 - val_loss: 0.4464 - val_ac
c: 0.4420
Epoch 116/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0261 - acc: 0.9929 - val_loss: 0.4358 - val_ac
c: 0.4520
Epoch 117/700
1/1 [==============================] - 0s 185ms/step - loss: 0.0261 - acc: 0.9929 - val_loss: 0.4272 - val_ac
c: 0.4600
Epoch 118/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0285 - acc: 0.9714 - val_loss: 0.4249 - val_ac
```

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c: 0.4600
Epoch 119/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0278 - acc: 0.9857 - val_loss: 0.4236 - val_ac
c: 0.4640
Epoch 120/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0322 - acc: 0.9500 - val_loss: 0.4177 - val_ac
c: 0.4960
Epoch 121/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0277 - acc: 0.9857 - val_loss: 0.4116 - val_ac
c: 0.5040
Epoch 122/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0298 - acc: 0.9857 - val_loss: 0.4136 - val_ac
c: 0.5200
Epoch 123/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0305 - acc: 0.9857 - val_loss: 0.4207 - val_ac
c: 0.5220
Epoch 124/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0306 - acc: 0.9714 - val_loss: 0.4290 - val_ac
c: 0.5140
Epoch 125/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0291 - acc: 0.9929 - val_loss: 0.4387 - val_ac
c: 0.5080
Epoch 126/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0324 - acc: 0.9714 - val_loss: 0.4537 - val_ac
c: 0.5160
Epoch 127/700
1/1 [==============================] - 0s 208ms/step - loss: 0.0304 - acc: 0.9929 - val_loss: 0.4702 - val_ac
c: 0.4900
Epoch 128/700
1/1 [==============================] - 0s 179ms/step - loss: 0.0357 - acc: 0.9786 - val_loss: 0.4720 - val_ac
c: 0.4760
Epoch 129/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0360 - acc: 0.9643 - val_loss: 0.4579 - val_ac
c: 0.4900
Epoch 130/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0331 - acc: 0.9857 - val_loss: 0.4616 - val_ac
c: 0.4720
Epoch 131/700
1/1 [==============================] - 0s 203ms/step - loss: 0.0338 - acc: 0.9714 - val_loss: 0.4665 - val_ac
c: 0.4760
Epoch 132/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0384 - acc: 0.9571 - val_loss: 0.4577 - val_ac
c: 0.4860
Epoch 133/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0357 - acc: 0.9786 - val_loss: 0.4395 - val_ac
c: 0.5080
Epoch 134/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0391 - acc: 0.9714 - val_loss: 0.4251 - val_ac
c: 0.5220
Epoch 135/700
1/1 [==============================] - 0s 219ms/step - loss: 0.0436 - acc: 0.9500 - val_loss: 0.4164 - val_ac
c: 0.5260
Epoch 136/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0367 - acc: 0.9786 - val_loss: 0.4143 - val_ac
c: 0.5280
Epoch 137/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0415 - acc: 0.9500 - val_loss: 0.4183 - val_ac
c: 0.5260
Epoch 138/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0389 - acc: 0.9643 - val_loss: 0.4265 - val_ac
c: 0.5280
Epoch 139/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0403 - acc: 0.9857 - val_loss: 0.4430 - val_ac
c: 0.5180
Epoch 140/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0397 - acc: 0.9786 - val_loss: 0.4427 - val_ac
c: 0.5180
Epoch 141/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0417 - acc: 0.9643 - val_loss: 0.4338 - val_ac
c: 0.5240
Epoch 142/700
```

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1/1 [==============================] - 0s 165ms/step - loss: 0.0435 - acc: 0.9571 - val_loss: 0.4148 - val_ac
c: 0.5600
Epoch 143/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0406 - acc: 0.9786 - val_loss: 0.4065 - val_ac
c: 0.5380
Epoch 144/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0417 - acc: 0.9857 - val_loss: 0.4060 - val_ac
c: 0.5360
Epoch 145/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0434 - acc: 0.9786 - val_loss: 0.4110 - val_ac
c: 0.5380
Epoch 146/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0466 - acc: 0.9571 - val_loss: 0.4290 - val_ac
c: 0.5220
Epoch 147/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0477 - acc: 0.9643 - val_loss: 0.4464 - val_ac
c: 0.5300
Epoch 148/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0480 - acc: 0.9571 - val_loss: 0.4582 - val_ac
c: 0.5200
Epoch 149/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0441 - acc: 0.9857 - val_loss: 0.4637 - val_ac
c: 0.5060
Epoch 150/700
1/1 [==============================] - 0s 159ms/step - loss: 0.0450 - acc: 0.9714 - val_loss: 0.4606 - val_ac
c: 0.5140
Epoch 151/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0483 - acc: 0.9500 - val_loss: 0.4479 - val_ac
c: 0.5060
Epoch 152/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0453 - acc: 0.9786 - val_loss: 0.4299 - val_ac
c: 0.5120
Epoch 153/700
1/1 [==============================] - 0s 206ms/step - loss: 0.0442 - acc: 0.9857 - val_loss: 0.4087 - val_ac
c: 0.5260
Epoch 154/700
1/1 [==============================] - 0s 200ms/step - loss: 0.0505 - acc: 0.9571 - val_loss: 0.3898 - val_ac
c: 0.5580
Epoch 155/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0468 - acc: 0.9786 - val_loss: 0.3762 - val_ac
c: 0.5520
Epoch 156/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0491 - acc: 0.9643 - val_loss: 0.3800 - val_ac
c: 0.5480
Epoch 157/700
1/1 [==============================] - 0s 214ms/step - loss: 0.0451 - acc: 0.9857 - val_loss: 0.4004 - val_ac
c: 0.5300
Epoch 158/700
1/1 [==============================] - 0s 190ms/step - loss: 0.0489 - acc: 0.9786 - val_loss: 0.4209 - val_ac
c: 0.5120
Epoch 159/700
1/1 [==============================] - 0s 176ms/step - loss: 0.0465 - acc: 0.9786 - val_loss: 0.4277 - val_ac
c: 0.5060
Epoch 160/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0464 - acc: 0.9571 - val_loss: 0.4249 - val_ac
c: 0.5000
Epoch 161/700
1/1 [==============================] - 0s 210ms/step - loss: 0.0434 - acc: 0.9857 - val_loss: 0.4197 - val_ac
c: 0.5080
Epoch 162/700
1/1 [==============================] - 0s 191ms/step - loss: 0.0507 - acc: 0.9500 - val_loss: 0.4126 - val_ac
c: 0.5300
Epoch 163/700
1/1 [==============================] - 0s 184ms/step - loss: 0.0456 - acc: 0.9786 - val_loss: 0.4206 - val_ac
c: 0.5320
Epoch 164/700
1/1 [==============================] - 0s 180ms/step - loss: 0.0465 - acc: 0.9786 - val_loss: 0.4382 - val_ac
c: 0.5120
Epoch 165/700
1/1 [==============================] - 0s 177ms/step - loss: 0.0502 - acc: 0.9500 - val_loss: 0.4402 - val_ac
c: 0.5080
```

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Epoch 166/700
1/1 [==============================] - 0s 179ms/step - loss: 0.0466 - acc: 0.9857 - val_loss: 0.4500 - val_ac
c: 0.4920
Epoch 167/700
1/1 [==============================] - 0s 181ms/step - loss: 0.0462 - acc: 0.9786 - val_loss: 0.4490 - val_ac
c: 0.4940
Epoch 168/700
1/1 [==============================] - 0s 191ms/step - loss: 0.0462 - acc: 0.9786 - val_loss: 0.4279 - val_ac
c: 0.5320
Epoch 169/700
1/1 [==============================] - 0s 181ms/step - loss: 0.0436 - acc: 0.9786 - val_loss: 0.4135 - val_ac
c: 0.5420
Epoch 170/700
1/1 [==============================] - 0s 183ms/step - loss: 0.0476 - acc: 0.9643 - val_loss: 0.4039 - val_ac
c: 0.5520
Epoch 171/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0410 - acc: 0.9929 - val_loss: 0.3982 - val_ac
c: 0.5520
Epoch 172/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0415 - acc: 0.9857 - val_loss: 0.3939 - val_ac
c: 0.5420
Epoch 173/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0454 - acc: 0.9643 - val_loss: 0.3891 - val_ac
c: 0.5480
Epoch 174/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0432 - acc: 0.9714 - val_loss: 0.3846 - val_ac
c: 0.5440
Epoch 175/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0417 - acc: 0.9714 - val_loss: 0.3834 - val_ac
c: 0.5480
Epoch 176/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0454 - acc: 0.9714 - val_loss: 0.3806 - val_ac
c: 0.5340
Epoch 177/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0407 - acc: 0.9786 - val_loss: 0.3774 - val_ac
c: 0.5420
Epoch 178/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0414 - acc: 0.9857 - val_loss: 0.3793 - val_ac
c: 0.5420
Epoch 179/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0414 - acc: 0.9714 - val_loss: 0.3779 - val_ac
c: 0.5420
Epoch 180/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0475 - acc: 0.9714 - val_loss: 0.3815 - val_ac
c: 0.5300
Epoch 181/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0399 - acc: 0.9786 - val_loss: 0.3866 - val_ac
c: 0.5180
Epoch 182/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0404 - acc: 0.9786 - val_loss: 0.3918 - val_ac
c: 0.5220
Epoch 183/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0365 - acc: 1.0000 - val_loss: 0.3990 - val_ac
c: 0.5120
Epoch 184/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0378 - acc: 0.9786 - val_loss: 0.4007 - val_ac
c: 0.5060
Epoch 185/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0360 - acc: 1.0000 - val_loss: 0.3998 - val_ac
c: 0.5120
Epoch 186/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0400 - acc: 0.9643 - val_loss: 0.3862 - val_ac
c: 0.5260
Epoch 187/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0422 - acc: 0.9214 - val_loss: 0.3721 - val_ac
c: 0.5360
Epoch 188/700
1/1 [==============================] - 0s 178ms/step - loss: 0.0372 - acc: 0.9714 - val_loss: 0.3644 - val_ac
c: 0.5420
Epoch 189/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0349 - acc: 0.9857 - val_loss: 0.3651 - val_ac
```

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c: 0.5400
Epoch 190/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0353 - acc: 0.9643 - val_loss: 0.3681 - val_ac
c: 0.5400
Epoch 191/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0347 - acc: 0.9857 - val_loss: 0.3700 - val_ac
c: 0.5340
Epoch 192/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0347 - acc: 0.9857 - val_loss: 0.3741 - val_ac
c: 0.5360
Epoch 193/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0342 - acc: 0.9857 - val_loss: 0.3775 - val_ac
c: 0.5360
Epoch 194/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0331 - acc: 1.0000 - val_loss: 0.3811 - val_ac
c: 0.5280
Epoch 195/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0346 - acc: 0.9714 - val_loss: 0.3837 - val_ac
c: 0.5200
Epoch 196/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0341 - acc: 0.9857 - val_loss: 0.3899 - val_ac
c: 0.5140
Epoch 197/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0337 - acc: 0.9857 - val_loss: 0.3897 - val_ac
c: 0.5080
Epoch 198/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0335 - acc: 0.9857 - val_loss: 0.3891 - val_ac
c: 0.5040
Epoch 199/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0329 - acc: 0.9857 - val_loss: 0.3966 - val_ac
c: 0.4800
Epoch 200/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0314 - acc: 0.9929 - val_loss: 0.4090 - val_ac
c: 0.4640
Epoch 201/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0347 - acc: 0.9714 - val_loss: 0.4181 - val_ac
c: 0.4480
Epoch 202/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0333 - acc: 0.9786 - val_loss: 0.4245 - val_ac
c: 0.4460
Epoch 203/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0341 - acc: 0.9571 - val_loss: 0.4035 - val_ac
c: 0.4680
Epoch 204/700
1/1 [==============================] - 0s 183ms/step - loss: 0.0353 - acc: 0.9643 - val_loss: 0.3829 - val_ac
c: 0.4880
Epoch 205/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0315 - acc: 0.9857 - val_loss: 0.3669 - val_ac
c: 0.5120
Epoch 206/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0324 - acc: 0.9857 - val_loss: 0.3597 - val_ac
c: 0.5240
Epoch 207/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0321 - acc: 0.9786 - val_loss: 0.3628 - val_ac
c: 0.5160
Epoch 208/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0315 - acc: 0.9857 - val_loss: 0.3724 - val_ac
c: 0.5140
Epoch 209/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0386 - acc: 0.9571 - val_loss: 0.3837 - val_ac
c: 0.5140
Epoch 210/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0307 - acc: 0.9857 - val_loss: 0.3995 - val_ac
c: 0.4840
Epoch 211/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0308 - acc: 0.9857 - val_loss: 0.4018 - val_ac
c: 0.4820
Epoch 212/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0310 - acc: 0.9786 - val_loss: 0.3978 - val_ac
c: 0.4940
Epoch 213/700
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1/1 [==============================] - 0s 169ms/step - loss: 0.0305 - acc: 0.9929 - val_loss: 0.3970 - val_ac
c: 0.4980
Epoch 214/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0358 - acc: 0.9714 - val_loss: 0.3874 - val_ac
c: 0.5120
Epoch 215/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0309 - acc: 0.9857 - val_loss: 0.3828 - val_ac
c: 0.5340
Epoch 216/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0340 - acc: 0.9857 - val_loss: 0.3757 - val_ac
c: 0.5440
Epoch 217/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0324 - acc: 0.9786 - val_loss: 0.3737 - val_ac
c: 0.5540
Epoch 218/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0344 - acc: 0.9643 - val_loss: 0.3692 - val_ac
c: 0.5660
Epoch 219/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0316 - acc: 0.9786 - val_loss: 0.3678 - val_ac
c: 0.5600
Epoch 220/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0315 - acc: 0.9857 - val_loss: 0.3691 - val_ac
c: 0.5560
Epoch 221/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0361 - acc: 0.9786 - val_loss: 0.3739 - val_ac
c: 0.5580
Epoch 222/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0332 - acc: 0.9714 - val_loss: 0.3798 - val_ac
c: 0.5520
Epoch 223/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0316 - acc: 0.9857 - val_loss: 0.3829 - val_ac
c: 0.5360
Epoch 224/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0344 - acc: 0.9643 - val_loss: 0.3877 - val_ac
c: 0.5260
Epoch 225/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0318 - acc: 0.9714 - val_loss: 0.3986 - val_ac
c: 0.5300
Epoch 226/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0318 - acc: 0.9786 - val_loss: 0.4086 - val_ac
c: 0.5320
Epoch 227/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0333 - acc: 0.9786 - val_loss: 0.4135 - val_ac
c: 0.5260
Epoch 228/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0333 - acc: 0.9714 - val_loss: 0.4082 - val_ac
c: 0.5200
Epoch 229/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0314 - acc: 0.9857 - val_loss: 0.4025 - val_ac
c: 0.5280
Epoch 230/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0314 - acc: 0.9857 - val_loss: 0.3998 - val_ac
c: 0.5280
Epoch 231/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0322 - acc: 0.9786 - val_loss: 0.3982 - val_ac
c: 0.5380
Epoch 232/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0325 - acc: 0.9714 - val_loss: 0.3943 - val_ac
c: 0.5420
Epoch 233/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0381 - acc: 0.9643 - val_loss: 0.3922 - val_ac
c: 0.5400
Epoch 234/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0391 - acc: 0.9571 - val_loss: 0.3947 - val_ac
c: 0.5280
Epoch 235/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0314 - acc: 0.9929 - val_loss: 0.4008 - val_ac
c: 0.5300
Epoch 236/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0339 - acc: 0.9786 - val_loss: 0.4094 - val_ac
c: 0.5260
```

```
Epoch 237/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0345 - acc: 0.9714 - val_loss: 0.4197 - val_ac
c: 0.5100
Epoch 238/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0355 - acc: 0.9571 - val_loss: 0.4297 - val_ac
c: 0.4960
Epoch 239/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0382 - acc: 0.9643 - val_loss: 0.4405 - val_ac
c: 0.4740
Epoch 240/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0348 - acc: 0.9786 - val_loss: 0.4456 - val_ac
c: 0.4700
Epoch 241/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0363 - acc: 0.9643 - val_loss: 0.4531 - val_ac
c: 0.4620
Epoch 242/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0357 - acc: 0.9786 - val_loss: 0.4586 - val_ac
c: 0.4640
Epoch 243/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0348 - acc: 0.9857 - val_loss: 0.4526 - val_ac
c: 0.4620
Epoch 244/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0406 - acc: 0.9429 - val_loss: 0.4325 - val_ac
c: 0.4760
Epoch 245/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0349 - acc: 1.0000 - val_loss: 0.4212 - val_ac
c: 0.4740
Epoch 246/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0381 - acc: 0.9857 - val_loss: 0.4112 - val_ac
c: 0.4940
Epoch 247/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0388 - acc: 0.9786 - val_loss: 0.4091 - val_ac
c: 0.5000
Epoch 248/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0395 - acc: 0.9714 - val_loss: 0.4076 - val_ac
c: 0.5100
Epoch 249/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0366 - acc: 0.9857 - val_loss: 0.4001 - val_ac
c: 0.5200
Epoch 250/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0373 - acc: 0.9857 - val_loss: 0.3995 - val_ac
c: 0.5280
Epoch 251/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0371 - acc: 0.9786 - val_loss: 0.4029 - val_ac
c: 0.5380
Epoch 252/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0462 - acc: 0.9500 - val_loss: 0.3984 - val_ac
c: 0.5480
Epoch 253/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0380 - acc: 0.9857 - val_loss: 0.3968 - val_ac
c: 0.5480
Epoch 254/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0375 - acc: 0.9857 - val_loss: 0.4000 - val_ac
c: 0.5340
Epoch 255/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0413 - acc: 0.9714 - val_loss: 0.4013 - val_ac
c: 0.5200
Epoch 256/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0390 - acc: 0.9786 - val_loss: 0.4033 - val_ac
c: 0.5280
Epoch 257/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0428 - acc: 0.9714 - val_loss: 0.3916 - val_ac
c: 0.5380
Epoch 258/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0386 - acc: 0.9786 - val_loss: 0.3807 - val_ac
c: 0.5440
Epoch 259/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0392 - acc: 0.9643 - val_loss: 0.3750 - val_ac
c: 0.5480
Epoch 260/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0421 - acc: 0.9429 - val_loss: 0.3733 - val_ac
```

```
c: 0.5580
Epoch 261/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0403 - acc: 0.9786 - val_loss: 0.3727 - val_ac
c: 0.5600
Epoch 262/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0365 - acc: 0.9857 - val_loss: 0.3749 - val_ac
c: 0.5520
Epoch 263/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0363 - acc: 1.0000 - val_loss: 0.3761 - val_ac
c: 0.5580
Epoch 264/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0366 - acc: 0.9929 - val_loss: 0.3791 - val_ac
c: 0.5680
Epoch 265/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0361 - acc: 0.9929 - val_loss: 0.3846 - val_ac
c: 0.5660
Epoch 266/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0443 - acc: 0.9643 - val_loss: 0.3833 - val_ac
c: 0.5620
Epoch 267/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0361 - acc: 0.9929 - val_loss: 0.3843 - val_ac
c: 0.5660
Epoch 268/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0367 - acc: 0.9929 - val_loss: 0.3850 - val_ac
c: 0.5620
Epoch 269/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0376 - acc: 0.9643 - val_loss: 0.3899 - val_ac
c: 0.5540
Epoch 270/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0373 - acc: 0.9857 - val_loss: 0.3985 - val_ac
c: 0.5420
Epoch 271/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0436 - acc: 0.9571 - val_loss: 0.4012 - val_ac
c: 0.5360
Epoch 272/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0374 - acc: 0.9857 - val_loss: 0.3979 - val_ac
c: 0.5380
Epoch 273/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0357 - acc: 0.9857 - val_loss: 0.3920 - val_ac
c: 0.5520
Epoch 274/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0359 - acc: 0.9786 - val_loss: 0.3854 - val_ac
c: 0.5540
Epoch 275/700
1/1 [==============================] - 0s 159ms/step - loss: 0.0360 - acc: 0.9786 - val_loss: 0.3821 - val_ac
c: 0.5480
Epoch 276/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0400 - acc: 0.9714 - val_loss: 0.3813 - val_ac
c: 0.5320
Epoch 277/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0408 - acc: 0.9571 - val_loss: 0.3820 - val_ac
c: 0.5380
Epoch 278/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0347 - acc: 0.9786 - val_loss: 0.3807 - val_ac
c: 0.5400
Epoch 279/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0332 - acc: 0.9929 - val_loss: 0.3838 - val_ac
c: 0.5380
Epoch 280/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0373 - acc: 0.9643 - val_loss: 0.3891 - val_ac
c: 0.5400
Epoch 281/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0399 - acc: 0.9571 - val_loss: 0.3881 - val_ac
c: 0.5420
Epoch 282/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0331 - acc: 0.9786 - val_loss: 0.3881 - val_ac
c: 0.5380
Epoch 283/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0365 - acc: 0.9857 - val_loss: 0.3889 - val_ac
c: 0.5360
Epoch 284/700
```

```
1/1 [==============================] - 0s 162ms/step - loss: 0.0372 - acc: 0.9786 - val_loss: 0.3921 - val_ac
c: 0.5320
Epoch 285/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0347 - acc: 0.9786 - val_loss: 0.3925 - val_ac
c: 0.5340
Epoch 286/700
1/1 [==============================] - 0s 157ms/step - loss: 0.0401 - acc: 0.9643 - val_loss: 0.4018 - val_ac
c: 0.5220
Epoch 287/700
1/1 [==============================] - 0s 191ms/step - loss: 0.0368 - acc: 0.9571 - val_loss: 0.4137 - val_ac
c: 0.5220
Epoch 288/700
1/1 [==============================] - 0s 174ms/step - loss: 0.0420 - acc: 0.9357 - val_loss: 0.4087 - val_ac
c: 0.5260
Epoch 289/700
1/1 [==============================] - 0s 183ms/step - loss: 0.0347 - acc: 0.9929 - val_loss: 0.4073 - val_ac
c: 0.5460
Epoch 290/700
1/1 [==============================] - 0s 185ms/step - loss: 0.0352 - acc: 0.9929 - val_loss: 0.4080 - val_ac
c: 0.5440
Epoch 291/700
1/1 [==============================] - 0s 193ms/step - loss: 0.0395 - acc: 0.9714 - val_loss: 0.4076 - val_ac
c: 0.5460
Epoch 292/700
1/1 [==============================] - 0s 188ms/step - loss: 0.0387 - acc: 0.9857 - val_loss: 0.4104 - val_ac
c: 0.5520
Epoch 293/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0391 - acc: 0.9786 - val_loss: 0.4155 - val_ac
c: 0.5620
Epoch 294/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0391 - acc: 0.9643 - val_loss: 0.4191 - val_ac
c: 0.5640
Epoch 295/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0402 - acc: 0.9643 - val_loss: 0.4250 - val_ac
c: 0.5580
Epoch 296/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0412 - acc: 0.9643 - val_loss: 0.4294 - val_ac
c: 0.5480
Epoch 297/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0386 - acc: 0.9786 - val_loss: 0.4378 - val_ac
c: 0.5320
Epoch 298/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0442 - acc: 0.9643 - val_loss: 0.4447 - val_ac
c: 0.5200
Epoch 299/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0397 - acc: 0.9714 - val_loss: 0.4550 - val_ac
c: 0.5040
Epoch 300/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0403 - acc: 0.9714 - val_loss: 0.4597 - val_ac
c: 0.5100
Epoch 301/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0415 - acc: 0.9786 - val_loss: 0.4522 - val_ac
c: 0.5120
Epoch 302/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0407 - acc: 0.9786 - val_loss: 0.4484 - val_ac
c: 0.5060
Epoch 303/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0443 - acc: 0.9500 - val_loss: 0.4527 - val_ac
c: 0.5040
Epoch 304/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0489 - acc: 0.9714 - val_loss: 0.4495 - val_ac
c: 0.5160
Epoch 305/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0419 - acc: 0.9571 - val_loss: 0.4509 - val_ac
c: 0.5120
Epoch 306/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0393 - acc: 0.9857 - val_loss: 0.4596 - val_ac
c: 0.5180
Epoch 307/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0427 - acc: 0.9571 - val_loss: 0.4779 - val_ac
c: 0.5040
```

```
Epoch 308/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0435 - acc: 0.9714 - val_loss: 0.5043 - val_ac
c: 0.4860
Epoch 309/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0483 - acc: 0.9500 - val_loss: 0.5223 - val_ac
c: 0.4860
Epoch 310/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0447 - acc: 0.9714 - val_loss: 0.5288 - val_ac
c: 0.4900
Epoch 311/700
1/1 [==============================] - 0s 170ms/step - loss: 0.0466 - acc: 0.9571 - val_loss: 0.5302 - val_ac
c: 0.4900
Epoch 312/700
1/1 [==============================] - 0s 175ms/step - loss: 0.0438 - acc: 0.9786 - val_loss: 0.5234 - val_ac
c: 0.4840
Epoch 313/700
1/1 [==============================] - 0s 201ms/step - loss: 0.0417 - acc: 0.9929 - val_loss: 0.5158 - val_ac
c: 0.4800
Epoch 314/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0492 - acc: 0.9714 - val_loss: 0.5032 - val_ac
c: 0.4900
Epoch 315/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0426 - acc: 0.9857 - val_loss: 0.4973 - val_ac
c: 0.4860
Epoch 316/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0446 - acc: 0.9857 - val_loss: 0.4922 - val_ac
c: 0.4840
Epoch 317/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0438 - acc: 0.9786 - val_loss: 0.4842 - val_ac
c: 0.4740
Epoch 318/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0559 - acc: 0.9500 - val_loss: 0.4850 - val_ac
c: 0.4920
Epoch 319/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0440 - acc: 0.9929 - val_loss: 0.4846 - val_ac
c: 0.4860
Epoch 320/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0510 - acc: 0.9643 - val_loss: 0.4900 - val_ac
c: 0.4820
Epoch 321/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0468 - acc: 0.9643 - val_loss: 0.4945 - val_ac
c: 0.4840
Epoch 322/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0470 - acc: 0.9714 - val_loss: 0.4962 - val_ac
c: 0.4900
Epoch 323/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0507 - acc: 0.9429 - val_loss: 0.4841 - val_ac
c: 0.4840
Epoch 324/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0455 - acc: 0.9857 - val_loss: 0.4740 - val_ac
c: 0.5020
Epoch 325/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0456 - acc: 0.9714 - val_loss: 0.4607 - val_ac
c: 0.5040
Epoch 326/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0468 - acc: 0.9714 - val_loss: 0.4421 - val_ac
c: 0.5140
Epoch 327/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0439 - acc: 0.9786 - val_loss: 0.4354 - val_ac
c: 0.5240
Epoch 328/700
1/1 [==============================] - 0s 173ms/step - loss: 0.0453 - acc: 0.9714 - val_loss: 0.4339 - val_ac
c: 0.5120
Epoch 329/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0456 - acc: 0.9786 - val_loss: 0.4330 - val_ac
c: 0.5140
Epoch 330/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0456 - acc: 0.9714 - val_loss: 0.4351 - val_ac
c: 0.5080
Epoch 331/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0461 - acc: 0.9643 - val_loss: 0.4394 - val_ac
```

```
c: 0.5080
Epoch 332/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0449 - acc: 0.9643 - val_loss: 0.4441 - val_ac
c: 0.5100
Epoch 333/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0439 - acc: 0.9714 - val_loss: 0.4587 - val_ac
c: 0.4980
Epoch 334/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0432 - acc: 0.9786 - val_loss: 0.4652 - val_ac
c: 0.4860
Epoch 335/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0432 - acc: 0.9857 - val_loss: 0.4699 - val_ac
c: 0.4800
Epoch 336/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0460 - acc: 0.9500 - val_loss: 0.4640 - val_ac
c: 0.4860
Epoch 337/700
1/1 [==============================] - 0s 160ms/step - loss: 0.0474 - acc: 0.9643 - val_loss: 0.4658 - val_ac
c: 0.4880
Epoch 338/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0479 - acc: 0.9643 - val_loss: 0.4772 - val_ac
c: 0.4780
Epoch 339/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0455 - acc: 0.9714 - val_loss: 0.4876 - val_ac
c: 0.4660
Epoch 340/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0477 - acc: 0.9500 - val_loss: 0.4912 - val_ac
c: 0.4600
Epoch 341/700
1/1 [==============================] - 0s 168ms/step - loss: 0.0469 - acc: 0.9643 - val_loss: 0.4982 - val_ac
c: 0.4540
Epoch 342/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0465 - acc: 0.9643 - val_loss: 0.4969 - val_ac
c: 0.4600
Epoch 343/700
1/1 [==============================] - 0s 169ms/step - loss: 0.0436 - acc: 0.9929 - val_loss: 0.4940 - val_ac
c: 0.4680
Epoch 344/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0450 - acc: 0.9714 - val_loss: 0.4876 - val_ac
c: 0.4700
Epoch 345/700
1/1 [==============================] - 0s 163ms/step - loss: 0.0471 - acc: 0.9500 - val_loss: 0.4678 - val_ac
c: 0.4660
Epoch 346/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0458 - acc: 0.9857 - val_loss: 0.4529 - val_ac
c: 0.4760
Epoch 347/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0479 - acc: 0.9857 - val_loss: 0.4382 - val_ac
c: 0.5100
Epoch 348/700
1/1 [==============================] - 0s 164ms/step - loss: 0.0461 - acc: 0.9786 - val_loss: 0.4318 - val_ac
c: 0.5280
Epoch 349/700
1/1 [==============================] - 0s 165ms/step - loss: 0.0473 - acc: 0.9786 - val_loss: 0.4232 - val_ac
c: 0.5400
Epoch 350/700
1/1 [==============================] - 0s 166ms/step - loss: 0.0478 - acc: 0.9571 - val_loss: 0.4163 - val_ac
c: 0.5420
Epoch 351/700
1/1 [==============================] - 0s 172ms/step - loss: 0.0440 - acc: 0.9857 - val_loss: 0.4108 - val_ac
c: 0.5440
Epoch 352/700
1/1 [==============================] - 0s 161ms/step - loss: 0.0483 - acc: 0.9643 - val_loss: 0.4087 - val_ac
c: 0.5460
Epoch 353/700
1/1 [==============================] - 0s 167ms/step - loss: 0.0487 - acc: 0.9643 - val_loss: 0.4054 - val_ac
c: 0.5440
Epoch 354/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0425 - acc: 0.9857 - val_loss: 0.4053 - val_ac
c: 0.5500
Epoch 355/700
```

```
1/1 [==============================] - 0s 176ms/step - loss: 0.0437 - acc: 0.9786 - val_loss: 0.4098 - val_ac
c: 0.5460
Epoch 356/700
1/1 [==============================] - 0s 171ms/step - loss: 0.0464 - acc: 0.9643 - val_loss: 0.4135 - val_ac
c: 0.5340
Epoch 357/700
1/1 [==============================] - 0s 162ms/step - loss: 0.0438 - acc: 0.9786 - val_loss: 0.4181 - val_ac
c: 0.5260
```

Out[ ]: <tensorflow.python.keras.callbacks.History at 0x23252d45d88>

In [ ]:
```
# Evaluate model
y_pred = model_fnn.predict(X_te)
report = classification_report(np.argmax(y_te,axis=1), np.argmax(y_pred,axis=1), target_names=classes)
print('FCNN Classification Report: \n {}'.format(report))
```

```
FCNN Classification Report:
                         precision    recall  f1-score   support

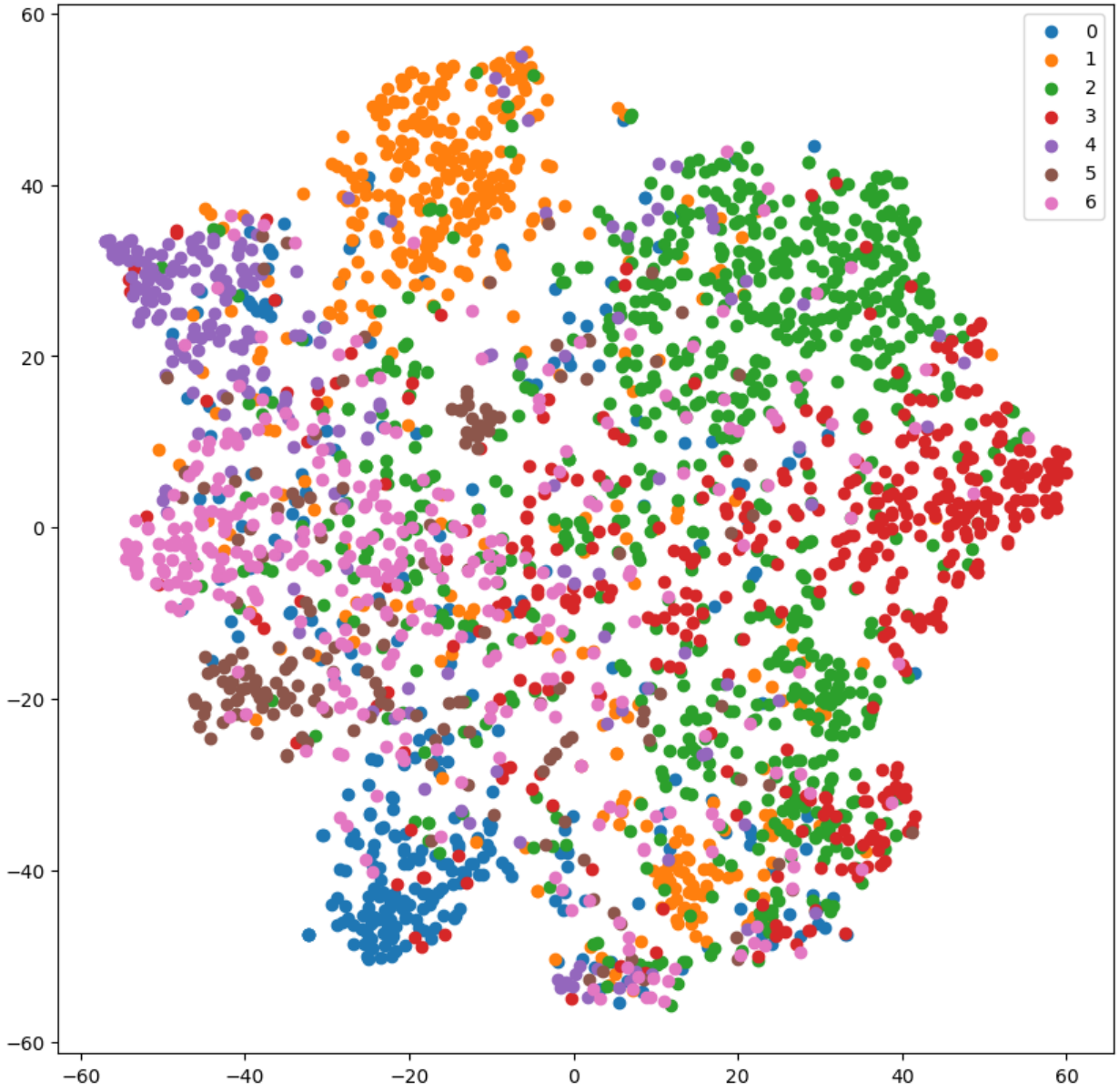
             Case_Based       0.62      0.54      0.57       114
    Genetic_Algorithms       0.71      0.74      0.72       156
       Neural_Networks       0.72      0.54      0.62       290
 Probabilistic_Methods       0.67      0.63      0.65       172
Reinforcement_Learning       0.46      0.55      0.50        85
         Rule_Learning       0.32      0.77      0.45        60
                Theory       0.44      0.40      0.42       123

              accuracy                           0.58      1000
             macro avg       0.56      0.59      0.56      1000
          weighted avg       0.62      0.58      0.59      1000
```

Get hidden layer representation for FNN

In [ ]:
```
layer_outputs = [layer.output for layer in model_fnn.layers]
activation_model = Model(inputs=model_fnn.input, outputs=layer_outputs)
activations = activation_model.predict([X])
```

In [ ]:
```
x_tsne = TSNE(n_components=2).fit_transform(activations[3])
plot_tSNE(labels_encoded,x_tsne)
```



In [ ]:
```
### END OF NOTEBOOK ###
```