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:  {'Theory', 'Rule_Learning', 'Genetic_Algorithms', 'Case_Based', 'Reinforcement_Learning', 'Proba
bilistic_Methods', 'Neural_Networks'}

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 = 600            # Number of training epochs
es_patience = 300        # 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 1/600
1/1 [==============================] - 0s 354ms/step - loss: 0.1172 - acc: 0.1000 - val_loss: 0.3671 - val_ac
c: 0.1860
Epoch 2/600
1/1 [==============================] - ETA: 0s - loss: 0.1096 - acc: 0.1857WARNING:tensorflow:Method (on_trai
n_batch_end) is slow compared to the batch update (0.175836). Check your callbacks.
1/1 [==============================] - 0s 176ms/step - loss: 0.1096 - acc: 0.1857 - val_loss: 0.3590 - val_ac
c: 0.2360
Epoch 3/600
1/1 [==============================] - 0s 176ms/step - loss: 0.1038 - acc: 0.3071 - val_loss: 0.3493 - val_ac
c: 0.2960
Epoch 4/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0985 - acc: 0.4071 - val_loss: 0.3385 - val_ac
c: 0.3020
Epoch 5/600
1/1 [==============================] - 0s 176ms/step - loss: 0.0941 - acc: 0.4214 - val_loss: 0.3282 - val_ac
c: 0.2760
Epoch 6/600
1/1 [==============================] - 0s 193ms/step - loss: 0.0889 - acc: 0.4857 - val_loss: 0.3204 - val_ac
c: 0.2600
Epoch 7/600
1/1 [==============================] - 0s 206ms/step - loss: 0.0870 - acc: 0.4571 - val_loss: 0.3137 - val_ac
c: 0.2700
Epoch 8/600
1/1 [==============================] - 0s 232ms/step - loss: 0.0841 - acc: 0.4714 - val_loss: 0.3066 - val_ac
c: 0.3240
Epoch 9/600
1/1 [==============================] - 0s 230ms/step - loss: 0.0818 - acc: 0.5286 - val_loss: 0.2993 - val_ac
c: 0.4080
Epoch 10/600
1/1 [==============================] - 0s 233ms/step - loss: 0.0799 - acc: 0.5786 - val_loss: 0.2923 - val_ac
c: 0.4940
Epoch 11/600
1/1 [==============================] - 0s 220ms/step - loss: 0.0790 - acc: 0.6143 - val_loss: 0.2859 - val_ac
c: 0.5520
Epoch 12/600
1/1 [==============================] - 0s 240ms/step - loss: 0.0765 - acc: 0.6786 - val_loss: 0.2798 - val_ac
c: 0.6040
Epoch 13/600
1/1 [==============================] - 0s 225ms/step - loss: 0.0754 - acc: 0.6643 - val_loss: 0.2739 - val_ac
c: 0.6260
Epoch 14/600
1/1 [==============================] - 0s 218ms/step - loss: 0.0741 - acc: 0.6929 - val_loss: 0.2679 - val_ac
c: 0.6400
Epoch 15/600
1/1 [==============================] - 0s 266ms/step - loss: 0.0746 - acc: 0.7214 - val_loss: 0.2621 - val_ac
c: 0.6500
Epoch 16/600
1/1 [==============================] - 0s 266ms/step - loss: 0.0715 - acc: 0.7500 - val_loss: 0.2565 - val_ac
c: 0.6620
Epoch 17/600
1/1 [==============================] - 0s 214ms/step - loss: 0.0692 - acc: 0.7571 - val_loss: 0.2512 - val_ac
c: 0.6780
Epoch 18/600
1/1 [==============================] - 0s 213ms/step - loss: 0.0667 - acc: 0.7643 - val_loss: 0.2463 - val_ac
c: 0.6940
Epoch 19/600
1/1 [==============================] - 0s 223ms/step - loss: 0.0680 - acc: 0.7643 - val_loss: 0.2414 - val_ac
c: 0.7060
Epoch 20/600
1/1 [==============================] - 0s 255ms/step - loss: 0.0656 - acc: 0.7857 - val_loss: 0.2365 - val_ac
c: 0.7140
Epoch 21/600
1/1 [==============================] - 0s 216ms/step - loss: 0.0637 - acc: 0.8429 - val_loss: 0.2322 - val_ac
c: 0.7320
Epoch 22/600
1/1 [==============================] - 0s 274ms/step - loss: 0.0638 - acc: 0.8429 - val_loss: 0.2283 - val_ac
c: 0.7400
Epoch 23/600
1/1 [==============================] - 0s 240ms/step - loss: 0.0626 - acc: 0.8000 - val_loss: 0.2245 - val_ac
c: 0.7520
```

```
Epoch 24/600
1/1 [==============================] - 0s 248ms/step - loss: 0.0601 - acc: 0.8571 - val_loss: 0.2207 - val_ac
c: 0.7640
Epoch 25/600
1/1 [==============================] - 0s 220ms/step - loss: 0.0585 - acc: 0.8714 - val_loss: 0.2172 - val_ac
c: 0.7660
Epoch 26/600
1/1 [==============================] - 0s 248ms/step - loss: 0.0563 - acc: 0.8929 - val_loss: 0.2138 - val_ac
c: 0.7600
Epoch 27/600
1/1 [==============================] - 0s 214ms/step - loss: 0.0575 - acc: 0.8643 - val_loss: 0.2111 - val_ac
c: 0.7600
Epoch 28/600
1/1 [==============================] - 0s 209ms/step - loss: 0.0565 - acc: 0.8929 - val_loss: 0.2088 - val_ac
c: 0.7600
Epoch 29/600
1/1 [==============================] - 0s 215ms/step - loss: 0.0543 - acc: 0.9143 - val_loss: 0.2061 - val_ac
c: 0.7740
Epoch 30/600
1/1 [==============================] - 0s 224ms/step - loss: 0.0540 - acc: 0.8643 - val_loss: 0.2035 - val_ac
c: 0.7820
Epoch 31/600
1/1 [==============================] - 0s 211ms/step - loss: 0.0551 - acc: 0.9000 - val_loss: 0.2008 - val_ac
c: 0.7840
Epoch 32/600
1/1 [==============================] - 0s 228ms/step - loss: 0.0517 - acc: 0.9000 - val_loss: 0.1980 - val_ac
c: 0.7900
Epoch 33/600
1/1 [==============================] - 0s 194ms/step - loss: 0.0489 - acc: 0.9143 - val_loss: 0.1954 - val_ac
c: 0.7900
Epoch 34/600
1/1 [==============================] - 0s 180ms/step - loss: 0.0529 - acc: 0.8929 - val_loss: 0.1925 - val_ac
c: 0.7920
Epoch 35/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0506 - acc: 0.9214 - val_loss: 0.1899 - val_ac
c: 0.7880
Epoch 36/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0502 - acc: 0.9357 - val_loss: 0.1876 - val_ac
c: 0.7880
Epoch 37/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0485 - acc: 0.9214 - val_loss: 0.1856 - val_ac
c: 0.7860
Epoch 38/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0475 - acc: 0.9286 - val_loss: 0.1840 - val_ac
c: 0.7800
Epoch 39/600
1/1 [==============================] - 0s 177ms/step - loss: 0.0472 - acc: 0.8929 - val_loss: 0.1825 - val_ac
c: 0.7820
Epoch 40/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0447 - acc: 0.9500 - val_loss: 0.1808 - val_ac
c: 0.7780
Epoch 41/600
1/1 [==============================] - 0s 181ms/step - loss: 0.0452 - acc: 0.9571 - val_loss: 0.1789 - val_ac
c: 0.7800
Epoch 42/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0475 - acc: 0.9429 - val_loss: 0.1773 - val_ac
c: 0.7780
Epoch 43/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0449 - acc: 0.9429 - val_loss: 0.1755 - val_ac
c: 0.7760
Epoch 44/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0436 - acc: 0.9429 - val_loss: 0.1736 - val_ac
c: 0.7720
Epoch 45/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0415 - acc: 0.9500 - val_loss: 0.1721 - val_ac
c: 0.7720
Epoch 46/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0439 - acc: 0.9500 - val_loss: 0.1715 - val_ac
c: 0.7740
Epoch 47/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0420 - acc: 0.9429 - val_loss: 0.1710 - val_ac
```

```
c: 0.7800
Epoch 48/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0406 - acc: 0.9714 - val_loss: 0.1716 - val_ac
c: 0.7760
Epoch 49/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0448 - acc: 0.9357 - val_loss: 0.1718 - val_ac
c: 0.7780
Epoch 50/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0366 - acc: 0.9929 - val_loss: 0.1711 - val_ac
c: 0.7740
Epoch 51/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0374 - acc: 0.9786 - val_loss: 0.1695 - val_ac
c: 0.7760
Epoch 52/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0411 - acc: 0.9500 - val_loss: 0.1670 - val_ac
c: 0.7800
Epoch 53/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0379 - acc: 0.9643 - val_loss: 0.1648 - val_ac
c: 0.7840
Epoch 54/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0378 - acc: 0.9714 - val_loss: 0.1635 - val_ac
c: 0.7820
Epoch 55/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0387 - acc: 0.9643 - val_loss: 0.1623 - val_ac
c: 0.7840
Epoch 56/600
1/1 [==============================] - 0s 178ms/step - loss: 0.0394 - acc: 0.9357 - val_loss: 0.1622 - val_ac
c: 0.7780
Epoch 57/600
1/1 [==============================] - 0s 178ms/step - loss: 0.0386 - acc: 0.9500 - val_loss: 0.1628 - val_ac
c: 0.7740
Epoch 58/600
1/1 [==============================] - 0s 176ms/step - loss: 0.0373 - acc: 0.9500 - val_loss: 0.1630 - val_ac
c: 0.7740
Epoch 59/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0406 - acc: 0.9143 - val_loss: 0.1633 - val_ac
c: 0.7740
Epoch 60/600
1/1 [==============================] - 0s 179ms/step - loss: 0.0367 - acc: 0.9643 - val_loss: 0.1629 - val_ac
c: 0.7740
Epoch 61/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0353 - acc: 0.9857 - val_loss: 0.1626 - val_ac
c: 0.7680
Epoch 62/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0379 - acc: 0.9643 - val_loss: 0.1627 - val_ac
c: 0.7680
Epoch 63/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0375 - acc: 0.9429 - val_loss: 0.1623 - val_ac
c: 0.7680
Epoch 64/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0359 - acc: 0.9429 - val_loss: 0.1613 - val_ac
c: 0.7680
Epoch 65/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0383 - acc: 0.9357 - val_loss: 0.1613 - val_ac
c: 0.7700
Epoch 66/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0353 - acc: 0.9500 - val_loss: 0.1615 - val_ac
c: 0.7720
Epoch 67/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0355 - acc: 0.9714 - val_loss: 0.1615 - val_ac
c: 0.7700
Epoch 68/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0334 - acc: 0.9643 - val_loss: 0.1615 - val_ac
c: 0.7680
Epoch 69/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0342 - acc: 0.9857 - val_loss: 0.1613 - val_ac
c: 0.7700
Epoch 70/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0379 - acc: 0.9143 - val_loss: 0.1611 - val_ac
c: 0.7660
Epoch 71/600
```

```
1/1 [==============================] - 0s 162ms/step - loss: 0.0351 - acc: 0.9571 - val_loss: 0.1614 - val_ac
c: 0.7640
Epoch 72/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0374 - acc: 0.9429 - val_loss: 0.1606 - val_ac
c: 0.7660
Epoch 73/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0336 - acc: 0.9500 - val_loss: 0.1598 - val_ac
c: 0.7700
Epoch 74/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0379 - acc: 0.9286 - val_loss: 0.1591 - val_ac
c: 0.7680
Epoch 75/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0347 - acc: 0.9429 - val_loss: 0.1583 - val_ac
c: 0.7700
Epoch 76/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0339 - acc: 0.9643 - val_loss: 0.1576 - val_ac
c: 0.7760
Epoch 77/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0318 - acc: 0.9929 - val_loss: 0.1563 - val_ac
c: 0.7800
Epoch 78/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0321 - acc: 0.9643 - val_loss: 0.1549 - val_ac
c: 0.7820
Epoch 79/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0323 - acc: 0.9714 - val_loss: 0.1537 - val_ac
c: 0.7840
Epoch 80/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0317 - acc: 0.9786 - val_loss: 0.1528 - val_ac
c: 0.7840
Epoch 81/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0335 - acc: 0.9643 - val_loss: 0.1520 - val_ac
c: 0.7860
Epoch 82/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0341 - acc: 0.9429 - val_loss: 0.1520 - val_ac
c: 0.7880
Epoch 83/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0353 - acc: 0.9429 - val_loss: 0.1528 - val_ac
c: 0.7860
Epoch 84/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0321 - acc: 0.9643 - val_loss: 0.1546 - val_ac
c: 0.7820
Epoch 85/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0353 - acc: 0.9429 - val_loss: 0.1578 - val_ac
c: 0.7740
Epoch 86/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0315 - acc: 0.9929 - val_loss: 0.1598 - val_ac
c: 0.7700
Epoch 87/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0341 - acc: 0.9786 - val_loss: 0.1605 - val_ac
c: 0.7680
Epoch 88/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0340 - acc: 0.9214 - val_loss: 0.1606 - val_ac
c: 0.7660
Epoch 89/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0331 - acc: 0.9500 - val_loss: 0.1594 - val_ac
c: 0.7640
Epoch 90/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0336 - acc: 0.9357 - val_loss: 0.1567 - val_ac
c: 0.7680
Epoch 91/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0351 - acc: 0.9429 - val_loss: 0.1538 - val_ac
c: 0.7800
Epoch 92/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0324 - acc: 0.9571 - val_loss: 0.1517 - val_ac
c: 0.7800
Epoch 93/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0295 - acc: 0.9714 - val_loss: 0.1497 - val_ac
c: 0.7840
Epoch 94/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0317 - acc: 0.9571 - val_loss: 0.1481 - val_ac
c: 0.7900
```

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Epoch 95/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0323 - acc: 0.9714 - val_loss: 0.1474 - val_ac
c: 0.7840
Epoch 96/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0327 - acc: 0.9429 - val_loss: 0.1480 - val_ac
c: 0.7820
Epoch 97/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0327 - acc: 0.9571 - val_loss: 0.1489 - val_ac
c: 0.7800
Epoch 98/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0317 - acc: 0.9500 - val_loss: 0.1511 - val_ac
c: 0.7780
Epoch 99/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0296 - acc: 0.9571 - val_loss: 0.1539 - val_ac
c: 0.7680
Epoch 100/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0333 - acc: 0.9571 - val_loss: 0.1552 - val_ac
c: 0.7720
Epoch 101/600
1/1 [==============================] - 0s 182ms/step - loss: 0.0311 - acc: 0.9643 - val_loss: 0.1565 - val_ac
c: 0.7680
Epoch 102/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0333 - acc: 0.9643 - val_loss: 0.1564 - val_ac
c: 0.7620
Epoch 103/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0314 - acc: 0.9429 - val_loss: 0.1547 - val_ac
c: 0.7700
Epoch 104/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0320 - acc: 0.9500 - val_loss: 0.1521 - val_ac
c: 0.7700
Epoch 105/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0291 - acc: 0.9786 - val_loss: 0.1491 - val_ac
c: 0.7780
Epoch 106/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0319 - acc: 0.9429 - val_loss: 0.1466 - val_ac
c: 0.7820
Epoch 107/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0293 - acc: 0.9500 - val_loss: 0.1449 - val_ac
c: 0.7860
Epoch 108/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0318 - acc: 0.9429 - val_loss: 0.1447 - val_ac
c: 0.7860
Epoch 109/600
1/1 [==============================] - 0s 204ms/step - loss: 0.0303 - acc: 0.9714 - val_loss: 0.1460 - val_ac
c: 0.7860
Epoch 110/600
1/1 [==============================] - 0s 182ms/step - loss: 0.0283 - acc: 0.9929 - val_loss: 0.1472 - val_ac
c: 0.7820
Epoch 111/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0297 - acc: 0.9929 - val_loss: 0.1481 - val_ac
c: 0.7900
Epoch 112/600
1/1 [==============================] - 0s 179ms/step - loss: 0.0285 - acc: 0.9786 - val_loss: 0.1492 - val_ac
c: 0.7820
Epoch 113/600
1/1 [==============================] - 0s 195ms/step - loss: 0.0298 - acc: 0.9643 - val_loss: 0.1495 - val_ac
c: 0.7840
Epoch 114/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0288 - acc: 0.9857 - val_loss: 0.1492 - val_ac
c: 0.7880
Epoch 115/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0322 - acc: 0.9429 - val_loss: 0.1493 - val_ac
c: 0.7780
Epoch 116/600
1/1 [==============================] - 0s 213ms/step - loss: 0.0304 - acc: 0.9643 - val_loss: 0.1490 - val_ac
c: 0.7720
Epoch 117/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0286 - acc: 0.9714 - val_loss: 0.1478 - val_ac
c: 0.7780
Epoch 118/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0278 - acc: 0.9714 - val_loss: 0.1457 - val_ac
```

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c: 0.7840
Epoch 119/600
1/1 [==============================] - 0s 208ms/step - loss: 0.0303 - acc: 0.9429 - val_loss: 0.1448 - val_ac
c: 0.7880
Epoch 120/600
1/1 [==============================] - 0s 183ms/step - loss: 0.0259 - acc: 0.9857 - val_loss: 0.1459 - val_ac
c: 0.7920
Epoch 121/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0274 - acc: 0.9714 - val_loss: 0.1483 - val_ac
c: 0.7920
Epoch 122/600
1/1 [==============================] - 0s 196ms/step - loss: 0.0298 - acc: 0.9500 - val_loss: 0.1489 - val_ac
c: 0.7860
Epoch 123/600
1/1 [==============================] - 0s 191ms/step - loss: 0.0283 - acc: 0.9571 - val_loss: 0.1487 - val_ac
c: 0.7860
Epoch 124/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0305 - acc: 0.9786 - val_loss: 0.1481 - val_ac
c: 0.7860
Epoch 125/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0259 - acc: 0.9786 - val_loss: 0.1468 - val_ac
c: 0.7840
Epoch 126/600
1/1 [==============================] - 0s 207ms/step - loss: 0.0297 - acc: 0.9571 - val_loss: 0.1467 - val_ac
c: 0.7760
Epoch 127/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0279 - acc: 0.9714 - val_loss: 0.1474 - val_ac
c: 0.7740
Epoch 128/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0291 - acc: 0.9429 - val_loss: 0.1482 - val_ac
c: 0.7720
Epoch 129/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0302 - acc: 0.9429 - val_loss: 0.1479 - val_ac
c: 0.7780
Epoch 130/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0285 - acc: 0.9643 - val_loss: 0.1481 - val_ac
c: 0.7820
Epoch 131/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0259 - acc: 0.9929 - val_loss: 0.1486 - val_ac
c: 0.7780
Epoch 132/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0288 - acc: 0.9571 - val_loss: 0.1499 - val_ac
c: 0.7740
Epoch 133/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0268 - acc: 0.9500 - val_loss: 0.1508 - val_ac
c: 0.7700
Epoch 134/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0266 - acc: 0.9714 - val_loss: 0.1509 - val_ac
c: 0.7700
Epoch 135/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0271 - acc: 0.9714 - val_loss: 0.1500 - val_ac
c: 0.7740
Epoch 136/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0277 - acc: 0.9571 - val_loss: 0.1478 - val_ac
c: 0.7700
Epoch 137/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0270 - acc: 0.9786 - val_loss: 0.1456 - val_ac
c: 0.7740
Epoch 138/600
1/1 [==============================] - 0s 181ms/step - loss: 0.0291 - acc: 0.9357 - val_loss: 0.1441 - val_ac
c: 0.7860
Epoch 139/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0287 - acc: 0.9357 - val_loss: 0.1447 - val_ac
c: 0.7880
Epoch 140/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0247 - acc: 0.9857 - val_loss: 0.1458 - val_ac
c: 0.7920
Epoch 141/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0261 - acc: 0.9929 - val_loss: 0.1468 - val_ac
c: 0.7900
Epoch 142/600
```

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1/1 [==============================] - 0s 169ms/step - loss: 0.0287 - acc: 0.9714 - val_loss: 0.1463 - val_ac
c: 0.7840
Epoch 143/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0273 - acc: 0.9571 - val_loss: 0.1461 - val_ac
c: 0.7800
Epoch 144/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0267 - acc: 0.9786 - val_loss: 0.1452 - val_ac
c: 0.7720
Epoch 145/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0267 - acc: 0.9643 - val_loss: 0.1444 - val_ac
c: 0.7760
Epoch 146/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0282 - acc: 0.9500 - val_loss: 0.1446 - val_ac
c: 0.7620
Epoch 147/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0263 - acc: 0.9857 - val_loss: 0.1455 - val_ac
c: 0.7680
Epoch 148/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0264 - acc: 0.9786 - val_loss: 0.1462 - val_ac
c: 0.7760
Epoch 149/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0278 - acc: 0.9571 - val_loss: 0.1470 - val_ac
c: 0.7820
Epoch 150/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0265 - acc: 0.9714 - val_loss: 0.1487 - val_ac
c: 0.7740
Epoch 151/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0263 - acc: 0.9500 - val_loss: 0.1492 - val_ac
c: 0.7740
Epoch 152/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0266 - acc: 0.9714 - val_loss: 0.1477 - val_ac
c: 0.7820
Epoch 153/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0252 - acc: 0.9786 - val_loss: 0.1458 - val_ac
c: 0.7820
Epoch 154/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0267 - acc: 0.9786 - val_loss: 0.1440 - val_ac
c: 0.7760
Epoch 155/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0255 - acc: 0.9786 - val_loss: 0.1430 - val_ac
c: 0.7820
Epoch 156/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0255 - acc: 0.9857 - val_loss: 0.1428 - val_ac
c: 0.7820
Epoch 157/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0257 - acc: 0.9643 - val_loss: 0.1435 - val_ac
c: 0.7800
Epoch 158/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0234 - acc: 0.9786 - val_loss: 0.1431 - val_ac
c: 0.7800
Epoch 159/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0257 - acc: 0.9571 - val_loss: 0.1416 - val_ac
c: 0.7760
Epoch 160/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0244 - acc: 0.9714 - val_loss: 0.1404 - val_ac
c: 0.7780
Epoch 161/600
1/1 [==============================] - 0s 178ms/step - loss: 0.0257 - acc: 0.9571 - val_loss: 0.1408 - val_ac
c: 0.7720
Epoch 162/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0257 - acc: 0.9714 - val_loss: 0.1416 - val_ac
c: 0.7840
Epoch 163/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0254 - acc: 0.9714 - val_loss: 0.1430 - val_ac
c: 0.7780
Epoch 164/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0236 - acc: 0.9786 - val_loss: 0.1442 - val_ac
c: 0.7820
Epoch 165/600
1/1 [==============================] - 0s 159ms/step - loss: 0.0239 - acc: 0.9857 - val_loss: 0.1451 - val_ac
c: 0.7760
```

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Epoch 166/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0252 - acc: 0.9929 - val_loss: 0.1466 - val_ac
c: 0.7620
Epoch 167/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0245 - acc: 0.9857 - val_loss: 0.1474 - val_ac
c: 0.7680
Epoch 168/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0247 - acc: 0.9643 - val_loss: 0.1482 - val_ac
c: 0.7740
Epoch 169/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0289 - acc: 0.9286 - val_loss: 0.1466 - val_ac
c: 0.7680
Epoch 170/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0273 - acc: 0.9429 - val_loss: 0.1446 - val_ac
c: 0.7740
Epoch 171/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0269 - acc: 0.9571 - val_loss: 0.1433 - val_ac
c: 0.7760
Epoch 172/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0238 - acc: 0.9786 - val_loss: 0.1428 - val_ac
c: 0.7800
Epoch 173/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0263 - acc: 0.9857 - val_loss: 0.1433 - val_ac
c: 0.7760
Epoch 174/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0247 - acc: 0.9714 - val_loss: 0.1431 - val_ac
c: 0.7800
Epoch 175/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0264 - acc: 0.9714 - val_loss: 0.1405 - val_ac
c: 0.7840
Epoch 176/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0245 - acc: 0.9429 - val_loss: 0.1389 - val_ac
c: 0.7800
Epoch 177/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0268 - acc: 0.9357 - val_loss: 0.1404 - val_ac
c: 0.7900
Epoch 178/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0257 - acc: 0.9857 - val_loss: 0.1423 - val_ac
c: 0.7960
Epoch 179/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0236 - acc: 0.9857 - val_loss: 0.1439 - val_ac
c: 0.7860
Epoch 180/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0255 - acc: 0.9786 - val_loss: 0.1459 - val_ac
c: 0.7800
Epoch 181/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0258 - acc: 0.9643 - val_loss: 0.1462 - val_ac
c: 0.7800
Epoch 182/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0266 - acc: 0.9500 - val_loss: 0.1454 - val_ac
c: 0.7800
Epoch 183/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0247 - acc: 0.9714 - val_loss: 0.1443 - val_ac
c: 0.7800
Epoch 184/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0271 - acc: 0.9500 - val_loss: 0.1422 - val_ac
c: 0.7820
Epoch 185/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0243 - acc: 0.9571 - val_loss: 0.1408 - val_ac
c: 0.7720
Epoch 186/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0258 - acc: 0.9643 - val_loss: 0.1387 - val_ac
c: 0.7780
Epoch 187/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0253 - acc: 0.9643 - val_loss: 0.1365 - val_ac
c: 0.7880
Epoch 188/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0246 - acc: 0.9643 - val_loss: 0.1346 - val_ac
c: 0.7880
Epoch 189/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0225 - acc: 0.9786 - val_loss: 0.1349 - val_ac
```

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c: 0.7920
Epoch 190/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0273 - acc: 0.9286 - val_loss: 0.1374 - val_ac
c: 0.7880
Epoch 191/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0234 - acc: 0.9929 - val_loss: 0.1423 - val_ac
c: 0.7820
Epoch 192/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0239 - acc: 0.9714 - val_loss: 0.1469 - val_ac
c: 0.7740
Epoch 193/600
1/1 [==============================] - 0s 177ms/step - loss: 0.0263 - acc: 0.9857 - val_loss: 0.1484 - val_ac
c: 0.7700
Epoch 194/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0251 - acc: 0.9643 - val_loss: 0.1476 - val_ac
c: 0.7700
Epoch 195/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0242 - acc: 0.9786 - val_loss: 0.1453 - val_ac
c: 0.7700
Epoch 196/600
1/1 [==============================] - 0s 209ms/step - loss: 0.0250 - acc: 0.9786 - val_loss: 0.1425 - val_ac
c: 0.7660
Epoch 197/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0241 - acc: 0.9714 - val_loss: 0.1401 - val_ac
c: 0.7840
Epoch 198/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0216 - acc: 0.9786 - val_loss: 0.1376 - val_ac
c: 0.7860
Epoch 199/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0248 - acc: 0.9714 - val_loss: 0.1361 - val_ac
c: 0.7820
Epoch 200/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0247 - acc: 0.9571 - val_loss: 0.1347 - val_ac
c: 0.7880
Epoch 201/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0223 - acc: 1.0000 - val_loss: 0.1334 - val_ac
c: 0.7880
Epoch 202/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0219 - acc: 0.9786 - val_loss: 0.1334 - val_ac
c: 0.7960
Epoch 203/600
1/1 [==============================] - 0s 180ms/step - loss: 0.0239 - acc: 0.9857 - val_loss: 0.1347 - val_ac
c: 0.7900
Epoch 204/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0214 - acc: 0.9786 - val_loss: 0.1376 - val_ac
c: 0.7860
Epoch 205/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0227 - acc: 0.9857 - val_loss: 0.1407 - val_ac
c: 0.7860
Epoch 206/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0227 - acc: 0.9786 - val_loss: 0.1423 - val_ac
c: 0.7800
Epoch 207/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0235 - acc: 0.9786 - val_loss: 0.1417 - val_ac
c: 0.7800
Epoch 208/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0236 - acc: 0.9714 - val_loss: 0.1414 - val_ac
c: 0.7740
Epoch 209/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0233 - acc: 0.9786 - val_loss: 0.1404 - val_ac
c: 0.7820
Epoch 210/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0210 - acc: 0.9929 - val_loss: 0.1393 - val_ac
c: 0.7820
Epoch 211/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0254 - acc: 0.9714 - val_loss: 0.1369 - val_ac
c: 0.7780
Epoch 212/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0212 - acc: 0.9929 - val_loss: 0.1357 - val_ac
c: 0.7800
Epoch 213/600
```

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1/1 [==============================] - 0s 169ms/step - loss: 0.0225 - acc: 0.9643 - val_loss: 0.1352 - val_ac
c: 0.7920
Epoch 214/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0216 - acc: 0.9643 - val_loss: 0.1357 - val_ac
c: 0.7920
Epoch 215/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0220 - acc: 0.9857 - val_loss: 0.1377 - val_ac
c: 0.7820
Epoch 216/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0223 - acc: 0.9786 - val_loss: 0.1396 - val_ac
c: 0.7860
Epoch 217/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0221 - acc: 0.9571 - val_loss: 0.1417 - val_ac
c: 0.7900
Epoch 218/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0226 - acc: 0.9786 - val_loss: 0.1417 - val_ac
c: 0.7800
Epoch 219/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0236 - acc: 0.9571 - val_loss: 0.1409 - val_ac
c: 0.7820
Epoch 220/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0221 - acc: 0.9714 - val_loss: 0.1389 - val_ac
c: 0.7840
Epoch 221/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0223 - acc: 0.9714 - val_loss: 0.1378 - val_ac
c: 0.7880
Epoch 222/600
1/1 [==============================] - 0s 179ms/step - loss: 0.0237 - acc: 0.9714 - val_loss: 0.1364 - val_ac
c: 0.7820
Epoch 223/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0244 - acc: 0.9500 - val_loss: 0.1368 - val_ac
c: 0.7820
Epoch 224/600
1/1 [==============================] - 0s 182ms/step - loss: 0.0235 - acc: 0.9714 - val_loss: 0.1378 - val_ac
c: 0.7800
Epoch 225/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0225 - acc: 0.9786 - val_loss: 0.1384 - val_ac
c: 0.7720
Epoch 226/600
1/1 [==============================] - 0s 176ms/step - loss: 0.0244 - acc: 0.9500 - val_loss: 0.1380 - val_ac
c: 0.7740
Epoch 227/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0221 - acc: 0.9786 - val_loss: 0.1369 - val_ac
c: 0.7800
Epoch 228/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0232 - acc: 0.9714 - val_loss: 0.1363 - val_ac
c: 0.7900
Epoch 229/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0234 - acc: 0.9714 - val_loss: 0.1368 - val_ac
c: 0.7940
Epoch 230/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0238 - acc: 0.9643 - val_loss: 0.1368 - val_ac
c: 0.7920
Epoch 231/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0217 - acc: 0.9857 - val_loss: 0.1369 - val_ac
c: 0.7900
Epoch 232/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0217 - acc: 0.9643 - val_loss: 0.1356 - val_ac
c: 0.7880
Epoch 233/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0229 - acc: 0.9643 - val_loss: 0.1343 - val_ac
c: 0.7900
Epoch 234/600
1/1 [==============================] - 0s 181ms/step - loss: 0.0224 - acc: 0.9786 - val_loss: 0.1338 - val_ac
c: 0.7800
Epoch 235/600
1/1 [==============================] - 0s 184ms/step - loss: 0.0224 - acc: 0.9786 - val_loss: 0.1355 - val_ac
c: 0.7760
Epoch 236/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0217 - acc: 0.9714 - val_loss: 0.1372 - val_ac
c: 0.7740
```

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Epoch 237/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0243 - acc: 0.9571 - val_loss: 0.1392 - val_ac
c: 0.7720
Epoch 238/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0219 - acc: 0.9714 - val_loss: 0.1425 - val_ac
c: 0.7780
Epoch 239/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0216 - acc: 0.9857 - val_loss: 0.1459 - val_ac
c: 0.7740
Epoch 240/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0215 - acc: 0.9643 - val_loss: 0.1455 - val_ac
c: 0.7780
Epoch 241/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0221 - acc: 0.9571 - val_loss: 0.1434 - val_ac
c: 0.7700
Epoch 242/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0219 - acc: 0.9786 - val_loss: 0.1421 - val_ac
c: 0.7740
Epoch 243/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0220 - acc: 0.9857 - val_loss: 0.1411 - val_ac
c: 0.7800
Epoch 244/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0223 - acc: 0.9786 - val_loss: 0.1395 - val_ac
c: 0.7740
Epoch 245/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0213 - acc: 0.9857 - val_loss: 0.1387 - val_ac
c: 0.7700
Epoch 246/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0215 - acc: 0.9857 - val_loss: 0.1378 - val_ac
c: 0.7720
Epoch 247/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0215 - acc: 0.9786 - val_loss: 0.1382 - val_ac
c: 0.7560
Epoch 248/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0216 - acc: 0.9500 - val_loss: 0.1417 - val_ac
c: 0.7700
Epoch 249/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0216 - acc: 0.9857 - val_loss: 0.1452 - val_ac
c: 0.7780
Epoch 250/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0197 - acc: 0.9929 - val_loss: 0.1471 - val_ac
c: 0.7720
Epoch 251/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0214 - acc: 0.9929 - val_loss: 0.1466 - val_ac
c: 0.7720
Epoch 252/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0187 - acc: 1.0000 - val_loss: 0.1449 - val_ac
c: 0.7760
Epoch 253/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0228 - acc: 0.9714 - val_loss: 0.1424 - val_ac
c: 0.7640
Epoch 254/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0226 - acc: 0.9786 - val_loss: 0.1404 - val_ac
c: 0.7660
Epoch 255/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0211 - acc: 0.9643 - val_loss: 0.1391 - val_ac
c: 0.7780
Epoch 256/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0210 - acc: 0.9929 - val_loss: 0.1381 - val_ac
c: 0.7780
Epoch 257/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0212 - acc: 0.9857 - val_loss: 0.1368 - val_ac
c: 0.7840
Epoch 258/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0220 - acc: 0.9786 - val_loss: 0.1360 - val_ac
c: 0.7760
Epoch 259/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0227 - acc: 0.9571 - val_loss: 0.1366 - val_ac
c: 0.7720
Epoch 260/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0215 - acc: 0.9786 - val_loss: 0.1385 - val_ac
```

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c: 0.7680
Epoch 261/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0199 - acc: 0.9929 - val_loss: 0.1404 - val_ac
c: 0.7660
Epoch 262/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0230 - acc: 0.9643 - val_loss: 0.1427 - val_ac
c: 0.7640
Epoch 263/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0201 - acc: 0.9857 - val_loss: 0.1450 - val_ac
c: 0.7680
Epoch 264/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0213 - acc: 0.9643 - val_loss: 0.1464 - val_ac
c: 0.7600
Epoch 265/600
1/1 [==============================] - 0s 177ms/step - loss: 0.0201 - acc: 0.9929 - val_loss: 0.1459 - val_ac
c: 0.7620
Epoch 266/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0196 - acc: 0.9857 - val_loss: 0.1441 - val_ac
c: 0.7620
Epoch 267/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0210 - acc: 0.9929 - val_loss: 0.1408 - val_ac
c: 0.7580
Epoch 268/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0200 - acc: 0.9857 - val_loss: 0.1376 - val_ac
c: 0.7660
Epoch 269/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0216 - acc: 0.9643 - val_loss: 0.1347 - val_ac
c: 0.7720
Epoch 270/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0197 - acc: 0.9786 - val_loss: 0.1342 - val_ac
c: 0.7680
Epoch 271/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0197 - acc: 0.9857 - val_loss: 0.1334 - val_ac
c: 0.7700
Epoch 272/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0216 - acc: 0.9643 - val_loss: 0.1334 - val_ac
c: 0.7800
Epoch 273/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0204 - acc: 0.9714 - val_loss: 0.1352 - val_ac
c: 0.7780
Epoch 274/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0196 - acc: 0.9714 - val_loss: 0.1400 - val_ac
c: 0.7840
Epoch 275/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0201 - acc: 0.9786 - val_loss: 0.1441 - val_ac
c: 0.7800
Epoch 276/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0206 - acc: 0.9929 - val_loss: 0.1467 - val_ac
c: 0.7680
Epoch 277/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0217 - acc: 0.9643 - val_loss: 0.1456 - val_ac
c: 0.7660
Epoch 278/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0224 - acc: 0.9643 - val_loss: 0.1416 - val_ac
c: 0.7680
Epoch 279/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0196 - acc: 0.9857 - val_loss: 0.1381 - val_ac
c: 0.7720
Epoch 280/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0199 - acc: 0.9857 - val_loss: 0.1369 - val_ac
c: 0.7780
Epoch 281/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0215 - acc: 0.9714 - val_loss: 0.1353 - val_ac
c: 0.7760
Epoch 282/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0216 - acc: 0.9643 - val_loss: 0.1349 - val_ac
c: 0.7760
Epoch 283/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0211 - acc: 0.9857 - val_loss: 0.1342 - val_ac
c: 0.7740
Epoch 284/600
```

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1/1 [==============================] - 0s 168ms/step - loss: 0.0199 - acc: 0.9857 - val_loss: 0.1350 - val_ac
c: 0.7720
Epoch 285/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0184 - acc: 1.0000 - val_loss: 0.1367 - val_ac
c: 0.7720
Epoch 286/600
1/1 [==============================] - 0s 183ms/step - loss: 0.0195 - acc: 0.9929 - val_loss: 0.1383 - val_ac
c: 0.7780
Epoch 287/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0199 - acc: 0.9857 - val_loss: 0.1395 - val_ac
c: 0.7760
Epoch 288/600
1/1 [==============================] - 0s 159ms/step - loss: 0.0230 - acc: 0.9571 - val_loss: 0.1403 - val_ac
c: 0.7660
Epoch 289/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0218 - acc: 0.9857 - val_loss: 0.1413 - val_ac
c: 0.7600
Epoch 290/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0192 - acc: 0.9786 - val_loss: 0.1431 - val_ac
c: 0.7520
Epoch 291/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0214 - acc: 0.9714 - val_loss: 0.1436 - val_ac
c: 0.7520
Epoch 292/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0226 - acc: 0.9500 - val_loss: 0.1426 - val_ac
c: 0.7580
Epoch 293/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0188 - acc: 0.9857 - val_loss: 0.1419 - val_ac
c: 0.7560
Epoch 294/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0195 - acc: 0.9786 - val_loss: 0.1393 - val_ac
c: 0.7660
Epoch 295/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0218 - acc: 0.9643 - val_loss: 0.1356 - val_ac
c: 0.7700
Epoch 296/600
1/1 [==============================] - 0s 182ms/step - loss: 0.0223 - acc: 0.9714 - val_loss: 0.1355 - val_ac
c: 0.7720
Epoch 297/600
1/1 [==============================] - 0s 180ms/step - loss: 0.0192 - acc: 0.9786 - val_loss: 0.1364 - val_ac
c: 0.7840
Epoch 298/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0202 - acc: 0.9714 - val_loss: 0.1384 - val_ac
c: 0.7780
Epoch 299/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0203 - acc: 1.0000 - val_loss: 0.1378 - val_ac
c: 0.7740
Epoch 300/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0199 - acc: 0.9714 - val_loss: 0.1376 - val_ac
c: 0.7680
Epoch 301/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0214 - acc: 0.9643 - val_loss: 0.1389 - val_ac
c: 0.7680
Epoch 302/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0222 - acc: 0.9714 - val_loss: 0.1386 - val_ac
c: 0.7640
Epoch 303/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0202 - acc: 0.9714 - val_loss: 0.1398 - val_ac
c: 0.7660
Epoch 304/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0191 - acc: 0.9857 - val_loss: 0.1416 - val_ac
c: 0.7720
Epoch 305/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0210 - acc: 0.9857 - val_loss: 0.1443 - val_ac
c: 0.7740
Epoch 306/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0203 - acc: 0.9786 - val_loss: 0.1450 - val_ac
c: 0.7660
Epoch 307/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0188 - acc: 1.0000 - val_loss: 0.1456 - val_ac
c: 0.7580
```

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Epoch 308/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0213 - acc: 0.9857 - val_loss: 0.1444 - val_ac
c: 0.7580
Epoch 309/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0217 - acc: 0.9571 - val_loss: 0.1426 - val_ac
c: 0.7640
Epoch 310/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0200 - acc: 0.9857 - val_loss: 0.1392 - val_ac
c: 0.7720
Epoch 311/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0200 - acc: 0.9786 - val_loss: 0.1383 - val_ac
c: 0.7720
Epoch 312/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0208 - acc: 0.9714 - val_loss: 0.1370 - val_ac
c: 0.7740
Epoch 313/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0185 - acc: 0.9857 - val_loss: 0.1371 - val_ac
c: 0.7740
Epoch 314/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0190 - acc: 0.9929 - val_loss: 0.1385 - val_ac
c: 0.7700
Epoch 315/600
1/1 [==============================] - 0s 177ms/step - loss: 0.0193 - acc: 0.9857 - val_loss: 0.1422 - val_ac
c: 0.7660
Epoch 316/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0194 - acc: 0.9786 - val_loss: 0.1465 - val_ac
c: 0.7640
Epoch 317/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0188 - acc: 0.9786 - val_loss: 0.1479 - val_ac
c: 0.7480
Epoch 318/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0208 - acc: 0.9643 - val_loss: 0.1456 - val_ac
c: 0.7460
Epoch 319/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0217 - acc: 0.9714 - val_loss: 0.1429 - val_ac
c: 0.7480
Epoch 320/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0189 - acc: 0.9929 - val_loss: 0.1395 - val_ac
c: 0.7680
Epoch 321/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0230 - acc: 0.9429 - val_loss: 0.1358 - val_ac
c: 0.7720
Epoch 322/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0197 - acc: 0.9714 - val_loss: 0.1331 - val_ac
c: 0.7820
Epoch 323/600
1/1 [==============================] - 0s 177ms/step - loss: 0.0188 - acc: 0.9929 - val_loss: 0.1322 - val_ac
c: 0.7880
Epoch 324/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0196 - acc: 0.9857 - val_loss: 0.1316 - val_ac
c: 0.7840
Epoch 325/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0211 - acc: 0.9643 - val_loss: 0.1322 - val_ac
c: 0.7880
Epoch 326/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0208 - acc: 0.9500 - val_loss: 0.1341 - val_ac
c: 0.7840
Epoch 327/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0189 - acc: 0.9857 - val_loss: 0.1368 - val_ac
c: 0.7740
Epoch 328/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0189 - acc: 0.9786 - val_loss: 0.1386 - val_ac
c: 0.7640
Epoch 329/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0185 - acc: 0.9929 - val_loss: 0.1414 - val_ac
c: 0.7580
Epoch 330/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0192 - acc: 0.9714 - val_loss: 0.1421 - val_ac
c: 0.7600
Epoch 331/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0191 - acc: 0.9929 - val_loss: 0.1417 - val_ac
```

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c: 0.7540
Epoch 332/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0192 - acc: 0.9786 - val_loss: 0.1411 - val_ac
c: 0.7520
Epoch 333/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0177 - acc: 0.9857 - val_loss: 0.1396 - val_ac
c: 0.7520
Epoch 334/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0195 - acc: 0.9714 - val_loss: 0.1404 - val_ac
c: 0.7600
Epoch 335/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0180 - acc: 0.9857 - val_loss: 0.1413 - val_ac
c: 0.7640
Epoch 336/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0221 - acc: 0.9571 - val_loss: 0.1420 - val_ac
c: 0.7680
Epoch 337/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0180 - acc: 0.9857 - val_loss: 0.1422 - val_ac
c: 0.7720
Epoch 338/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0189 - acc: 0.9786 - val_loss: 0.1409 - val_ac
c: 0.7720
Epoch 339/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0186 - acc: 0.9786 - val_loss: 0.1380 - val_ac
c: 0.7820
Epoch 340/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0188 - acc: 0.9857 - val_loss: 0.1358 - val_ac
c: 0.7880
Epoch 341/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0193 - acc: 0.9786 - val_loss: 0.1340 - val_ac
c: 0.7880
Epoch 342/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0193 - acc: 0.9571 - val_loss: 0.1322 - val_ac
c: 0.7980
Epoch 343/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0193 - acc: 0.9714 - val_loss: 0.1321 - val_ac
c: 0.8040
Epoch 344/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0200 - acc: 0.9643 - val_loss: 0.1324 - val_ac
c: 0.8040
Epoch 345/600
1/1 [==============================] - 0s 178ms/step - loss: 0.0202 - acc: 0.9643 - val_loss: 0.1342 - val_ac
c: 0.7940
Epoch 346/600
1/1 [==============================] - 0s 193ms/step - loss: 0.0206 - acc: 0.9643 - val_loss: 0.1377 - val_ac
c: 0.7920
Epoch 347/600
1/1 [==============================] - 0s 180ms/step - loss: 0.0190 - acc: 0.9714 - val_loss: 0.1407 - val_ac
c: 0.7820
Epoch 348/600
1/1 [==============================] - 0s 180ms/step - loss: 0.0188 - acc: 0.9857 - val_loss: 0.1412 - val_ac
c: 0.7800
Epoch 349/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0194 - acc: 0.9857 - val_loss: 0.1437 - val_ac
c: 0.7640
Epoch 350/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0211 - acc: 0.9571 - val_loss: 0.1434 - val_ac
c: 0.7620
Epoch 351/600
1/1 [==============================] - 0s 184ms/step - loss: 0.0192 - acc: 0.9857 - val_loss: 0.1421 - val_ac
c: 0.7680
Epoch 352/600
1/1 [==============================] - 0s 187ms/step - loss: 0.0207 - acc: 0.9714 - val_loss: 0.1396 - val_ac
c: 0.7600
Epoch 353/600
1/1 [==============================] - 0s 181ms/step - loss: 0.0189 - acc: 0.9786 - val_loss: 0.1380 - val_ac
c: 0.7700
Epoch 354/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0196 - acc: 0.9786 - val_loss: 0.1388 - val_ac
c: 0.7840
Epoch 355/600
```

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1/1 [==============================] - 0s 169ms/step - loss: 0.0191 - acc: 0.9714 - val_loss: 0.1390 - val_ac
c: 0.7760
Epoch 356/600
1/1 [==============================] - 0s 179ms/step - loss: 0.0206 - acc: 0.9786 - val_loss: 0.1395 - val_ac
c: 0.7740
Epoch 357/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0194 - acc: 0.9857 - val_loss: 0.1403 - val_ac
c: 0.7800
Epoch 358/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0187 - acc: 0.9857 - val_loss: 0.1410 - val_ac
c: 0.7840
Epoch 359/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0192 - acc: 0.9929 - val_loss: 0.1410 - val_ac
c: 0.7860
Epoch 360/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0195 - acc: 0.9929 - val_loss: 0.1396 - val_ac
c: 0.7820
Epoch 361/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0180 - acc: 0.9786 - val_loss: 0.1386 - val_ac
c: 0.7740
Epoch 362/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0188 - acc: 0.9857 - val_loss: 0.1368 - val_ac
c: 0.7680
Epoch 363/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0175 - acc: 0.9929 - val_loss: 0.1366 - val_ac
c: 0.7620
Epoch 364/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0195 - acc: 0.9714 - val_loss: 0.1363 - val_ac
c: 0.7580
Epoch 365/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0211 - acc: 0.9571 - val_loss: 0.1326 - val_ac
c: 0.7720
Epoch 366/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0195 - acc: 0.9786 - val_loss: 0.1303 - val_ac
c: 0.7820
Epoch 367/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0199 - acc: 0.9714 - val_loss: 0.1324 - val_ac
c: 0.7820
Epoch 368/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0182 - acc: 0.9643 - val_loss: 0.1368 - val_ac
c: 0.7720
Epoch 369/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0184 - acc: 0.9786 - val_loss: 0.1391 - val_ac
c: 0.7720
Epoch 370/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0190 - acc: 0.9857 - val_loss: 0.1425 - val_ac
c: 0.7740
Epoch 371/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0194 - acc: 0.9643 - val_loss: 0.1432 - val_ac
c: 0.7620
Epoch 372/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0191 - acc: 0.9714 - val_loss: 0.1427 - val_ac
c: 0.7600
Epoch 373/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0195 - acc: 0.9857 - val_loss: 0.1421 - val_ac
c: 0.7560
Epoch 374/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0194 - acc: 0.9786 - val_loss: 0.1413 - val_ac
c: 0.7540
Epoch 375/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0205 - acc: 0.9643 - val_loss: 0.1381 - val_ac
c: 0.7640
Epoch 376/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0188 - acc: 0.9786 - val_loss: 0.1364 - val_ac
c: 0.7680
Epoch 377/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0190 - acc: 0.9786 - val_loss: 0.1340 - val_ac
c: 0.7780
Epoch 378/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0190 - acc: 0.9786 - val_loss: 0.1325 - val_ac
c: 0.7860
```

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Epoch 379/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0197 - acc: 0.9643 - val_loss: 0.1305 - val_ac
c: 0.7920
Epoch 380/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0182 - acc: 0.9857 - val_loss: 0.1301 - val_ac
c: 0.7860
Epoch 381/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0186 - acc: 0.9786 - val_loss: 0.1321 - val_ac
c: 0.7820
Epoch 382/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0181 - acc: 0.9786 - val_loss: 0.1355 - val_ac
c: 0.7740
Epoch 383/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0200 - acc: 0.9929 - val_loss: 0.1396 - val_ac
c: 0.7700
Epoch 384/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0203 - acc: 0.9714 - val_loss: 0.1413 - val_ac
c: 0.7640
Epoch 385/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0177 - acc: 0.9857 - val_loss: 0.1420 - val_ac
c: 0.7600
Epoch 386/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0183 - acc: 0.9857 - val_loss: 0.1398 - val_ac
c: 0.7680
Epoch 387/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0178 - acc: 0.9786 - val_loss: 0.1369 - val_ac
c: 0.7700
Epoch 388/600
1/1 [==============================] - 0s 177ms/step - loss: 0.0184 - acc: 0.9643 - val_loss: 0.1325 - val_ac
c: 0.7780
Epoch 389/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0204 - acc: 0.9857 - val_loss: 0.1302 - val_ac
c: 0.7780
Epoch 390/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0176 - acc: 0.9857 - val_loss: 0.1299 - val_ac
c: 0.7820
Epoch 391/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0181 - acc: 0.9786 - val_loss: 0.1301 - val_ac
c: 0.7840
Epoch 392/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0195 - acc: 0.9643 - val_loss: 0.1295 - val_ac
c: 0.7820
Epoch 393/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0193 - acc: 0.9714 - val_loss: 0.1299 - val_ac
c: 0.7860
Epoch 394/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0165 - acc: 0.9786 - val_loss: 0.1326 - val_ac
c: 0.7840
Epoch 395/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0183 - acc: 0.9714 - val_loss: 0.1360 - val_ac
c: 0.7720
Epoch 396/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0182 - acc: 0.9857 - val_loss: 0.1415 - val_ac
c: 0.7640
Epoch 397/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0176 - acc: 0.9643 - val_loss: 0.1463 - val_ac
c: 0.7640
Epoch 398/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0200 - acc: 0.9500 - val_loss: 0.1441 - val_ac
c: 0.7700
Epoch 399/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0183 - acc: 0.9786 - val_loss: 0.1415 - val_ac
c: 0.7740
Epoch 400/600
1/1 [==============================] - 0s 186ms/step - loss: 0.0192 - acc: 0.9786 - val_loss: 0.1375 - val_ac
c: 0.7720
Epoch 401/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0203 - acc: 0.9571 - val_loss: 0.1352 - val_ac
c: 0.7780
Epoch 402/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0180 - acc: 0.9929 - val_loss: 0.1338 - val_ac
```

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c: 0.7840
Epoch 403/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0179 - acc: 0.9929 - val_loss: 0.1333 - val_ac
c: 0.7840
Epoch 404/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0178 - acc: 0.9714 - val_loss: 0.1324 - val_ac
c: 0.7900
Epoch 405/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0177 - acc: 0.9929 - val_loss: 0.1319 - val_ac
c: 0.7940
Epoch 406/600
1/1 [==============================] - 0s 178ms/step - loss: 0.0194 - acc: 0.9857 - val_loss: 0.1325 - val_ac
c: 0.7900
Epoch 407/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0196 - acc: 0.9500 - val_loss: 0.1363 - val_ac
c: 0.7820
Epoch 408/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0179 - acc: 0.9786 - val_loss: 0.1403 - val_ac
c: 0.7760
Epoch 409/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0184 - acc: 0.9857 - val_loss: 0.1438 - val_ac
c: 0.7620
Epoch 410/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0191 - acc: 0.9786 - val_loss: 0.1460 - val_ac
c: 0.7560
Epoch 411/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0200 - acc: 0.9714 - val_loss: 0.1436 - val_ac
c: 0.7560
Epoch 412/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0194 - acc: 0.9643 - val_loss: 0.1413 - val_ac
c: 0.7700
Epoch 413/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0174 - acc: 0.9857 - val_loss: 0.1423 - val_ac
c: 0.7600
Epoch 414/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0179 - acc: 0.9786 - val_loss: 0.1445 - val_ac
c: 0.7620
Epoch 415/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0181 - acc: 0.9929 - val_loss: 0.1451 - val_ac
c: 0.7680
Epoch 416/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0198 - acc: 0.9714 - val_loss: 0.1426 - val_ac
c: 0.7740
Epoch 417/600
1/1 [==============================] - 0s 159ms/step - loss: 0.0182 - acc: 0.9714 - val_loss: 0.1394 - val_ac
c: 0.7780
Epoch 418/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0181 - acc: 0.9786 - val_loss: 0.1390 - val_ac
c: 0.7760
Epoch 419/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0168 - acc: 0.9929 - val_loss: 0.1393 - val_ac
c: 0.7680
Epoch 420/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0184 - acc: 0.9857 - val_loss: 0.1404 - val_ac
c: 0.7680
Epoch 421/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0183 - acc: 0.9643 - val_loss: 0.1377 - val_ac
c: 0.7700
Epoch 422/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0192 - acc: 0.9643 - val_loss: 0.1352 - val_ac
c: 0.7680
Epoch 423/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0177 - acc: 0.9857 - val_loss: 0.1337 - val_ac
c: 0.7740
Epoch 424/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0196 - acc: 0.9643 - val_loss: 0.1314 - val_ac
c: 0.7800
Epoch 425/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0170 - acc: 0.9857 - val_loss: 0.1305 - val_ac
c: 0.7860
Epoch 426/600
```

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1/1 [==============================] - 0s 169ms/step - loss: 0.0174 - acc: 0.9857 - val_loss: 0.1330 - val_ac
c: 0.7760
Epoch 427/600
1/1 [==============================] - 0s 185ms/step - loss: 0.0176 - acc: 0.9786 - val_loss: 0.1344 - val_ac
c: 0.7640
Epoch 428/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0187 - acc: 0.9714 - val_loss: 0.1344 - val_ac
c: 0.7720
Epoch 429/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0174 - acc: 0.9929 - val_loss: 0.1358 - val_ac
c: 0.7660
Epoch 430/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0178 - acc: 0.9786 - val_loss: 0.1389 - val_ac
c: 0.7640
Epoch 431/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0184 - acc: 0.9929 - val_loss: 0.1397 - val_ac
c: 0.7600
Epoch 432/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0184 - acc: 0.9786 - val_loss: 0.1384 - val_ac
c: 0.7620
Epoch 433/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0176 - acc: 0.9857 - val_loss: 0.1340 - val_ac
c: 0.7640
Epoch 434/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0176 - acc: 0.9714 - val_loss: 0.1309 - val_ac
c: 0.7660
Epoch 435/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0167 - acc: 0.9857 - val_loss: 0.1304 - val_ac
c: 0.7740
Epoch 436/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0193 - acc: 0.9714 - val_loss: 0.1319 - val_ac
c: 0.7640
Epoch 437/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0186 - acc: 0.9643 - val_loss: 0.1359 - val_ac
c: 0.7640
Epoch 438/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0178 - acc: 0.9857 - val_loss: 0.1398 - val_ac
c: 0.7540
Epoch 439/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0182 - acc: 0.9786 - val_loss: 0.1429 - val_ac
c: 0.7500
Epoch 440/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0174 - acc: 0.9714 - val_loss: 0.1454 - val_ac
c: 0.7560
Epoch 441/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0182 - acc: 0.9714 - val_loss: 0.1454 - val_ac
c: 0.7620
Epoch 442/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0180 - acc: 0.9857 - val_loss: 0.1438 - val_ac
c: 0.7560
Epoch 443/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0190 - acc: 0.9857 - val_loss: 0.1399 - val_ac
c: 0.7580
Epoch 444/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0178 - acc: 0.9857 - val_loss: 0.1373 - val_ac
c: 0.7600
Epoch 445/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0182 - acc: 0.9786 - val_loss: 0.1364 - val_ac
c: 0.7600
Epoch 446/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0191 - acc: 0.9643 - val_loss: 0.1372 - val_ac
c: 0.7680
Epoch 447/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0205 - acc: 0.9643 - val_loss: 0.1365 - val_ac
c: 0.7580
Epoch 448/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0174 - acc: 0.9571 - val_loss: 0.1417 - val_ac
c: 0.7580
Epoch 449/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0193 - acc: 0.9643 - val_loss: 0.1486 - val_ac
c: 0.7600
```

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Epoch 450/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0177 - acc: 0.9714 - val_loss: 0.1541 - val_ac
c: 0.7540
Epoch 451/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0170 - acc: 0.9857 - val_loss: 0.1545 - val_ac
c: 0.7560
Epoch 452/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0179 - acc: 0.9857 - val_loss: 0.1489 - val_ac
c: 0.7540
Epoch 453/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0186 - acc: 0.9786 - val_loss: 0.1430 - val_ac
c: 0.7600
Epoch 454/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0190 - acc: 0.9643 - val_loss: 0.1375 - val_ac
c: 0.7660
Epoch 455/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0174 - acc: 0.9786 - val_loss: 0.1346 - val_ac
c: 0.7720
Epoch 456/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0191 - acc: 0.9786 - val_loss: 0.1323 - val_ac
c: 0.7760
Epoch 457/600
1/1 [==============================] - 0s 179ms/step - loss: 0.0187 - acc: 0.9714 - val_loss: 0.1311 - val_ac
c: 0.7860
Epoch 458/600
1/1 [==============================] - 0s 177ms/step - loss: 0.0193 - acc: 0.9786 - val_loss: 0.1290 - val_ac
c: 0.7920
Epoch 459/600
1/1 [==============================] - 0s 180ms/step - loss: 0.0185 - acc: 0.9929 - val_loss: 0.1293 - val_ac
c: 0.7860
Epoch 460/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0179 - acc: 0.9857 - val_loss: 0.1301 - val_ac
c: 0.7840
Epoch 461/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0174 - acc: 0.9786 - val_loss: 0.1326 - val_ac
c: 0.7800
Epoch 462/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0169 - acc: 0.9857 - val_loss: 0.1350 - val_ac
c: 0.7700
Epoch 463/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0179 - acc: 0.9714 - val_loss: 0.1379 - val_ac
c: 0.7700
Epoch 464/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0192 - acc: 0.9643 - val_loss: 0.1401 - val_ac
c: 0.7640
Epoch 465/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0163 - acc: 0.9857 - val_loss: 0.1413 - val_ac
c: 0.7660
Epoch 466/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0195 - acc: 0.9714 - val_loss: 0.1413 - val_ac
c: 0.7660
Epoch 467/600
1/1 [==============================] - 0s 176ms/step - loss: 0.0173 - acc: 0.9857 - val_loss: 0.1399 - val_ac
c: 0.7740
Epoch 468/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0179 - acc: 0.9857 - val_loss: 0.1368 - val_ac
c: 0.7780
Epoch 469/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0160 - acc: 1.0000 - val_loss: 0.1353 - val_ac
c: 0.7740
Epoch 470/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0186 - acc: 0.9714 - val_loss: 0.1362 - val_ac
c: 0.7680
Epoch 471/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0179 - acc: 0.9714 - val_loss: 0.1351 - val_ac
c: 0.7700
Epoch 472/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0177 - acc: 0.9500 - val_loss: 0.1353 - val_ac
c: 0.7740
Epoch 473/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0179 - acc: 0.9643 - val_loss: 0.1358 - val_ac
```

```
c: 0.7740
Epoch 474/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0175 - acc: 0.9786 - val_loss: 0.1385 - val_ac
c: 0.7740
Epoch 475/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0179 - acc: 0.9857 - val_loss: 0.1416 - val_ac
c: 0.7700
Epoch 476/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0172 - acc: 0.9857 - val_loss: 0.1434 - val_ac
c: 0.7680
Epoch 477/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0159 - acc: 0.9786 - val_loss: 0.1420 - val_ac
c: 0.7660
Epoch 478/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0170 - acc: 0.9929 - val_loss: 0.1395 - val_ac
c: 0.7660
Epoch 479/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0185 - acc: 0.9857 - val_loss: 0.1366 - val_ac
c: 0.7640
Epoch 480/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0153 - acc: 1.0000 - val_loss: 0.1335 - val_ac
c: 0.7740
Epoch 481/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0165 - acc: 0.9857 - val_loss: 0.1329 - val_ac
c: 0.7680
Epoch 482/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0179 - acc: 0.9929 - val_loss: 0.1329 - val_ac
c: 0.7640
Epoch 483/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0157 - acc: 0.9929 - val_loss: 0.1334 - val_ac
c: 0.7580
Epoch 484/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0152 - acc: 0.9857 - val_loss: 0.1349 - val_ac
c: 0.7620
Epoch 485/600
1/1 [==============================] - 0s 176ms/step - loss: 0.0169 - acc: 0.9571 - val_loss: 0.1380 - val_ac
c: 0.7560
Epoch 486/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0166 - acc: 0.9857 - val_loss: 0.1376 - val_ac
c: 0.7580
Epoch 487/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0188 - acc: 0.9643 - val_loss: 0.1358 - val_ac
c: 0.7740
Epoch 488/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0164 - acc: 0.9857 - val_loss: 0.1352 - val_ac
c: 0.7820
Epoch 489/600
1/1 [==============================] - 0s 177ms/step - loss: 0.0176 - acc: 0.9714 - val_loss: 0.1351 - val_ac
c: 0.7840
Epoch 490/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0173 - acc: 0.9786 - val_loss: 0.1345 - val_ac
c: 0.7820
Epoch 491/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0179 - acc: 0.9714 - val_loss: 0.1338 - val_ac
c: 0.7820
Epoch 492/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0191 - acc: 0.9786 - val_loss: 0.1352 - val_ac
c: 0.7720
Epoch 493/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0188 - acc: 0.9571 - val_loss: 0.1360 - val_ac
c: 0.7780
Epoch 494/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0170 - acc: 0.9786 - val_loss: 0.1369 - val_ac
c: 0.7800
Epoch 495/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0172 - acc: 0.9786 - val_loss: 0.1402 - val_ac
c: 0.7740
Epoch 496/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0179 - acc: 0.9857 - val_loss: 0.1444 - val_ac
c: 0.7660
Epoch 497/600
```

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1/1 [==============================] - 0s 161ms/step - loss: 0.0187 - acc: 0.9857 - val_loss: 0.1446 - val_ac
c: 0.7700
Epoch 498/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0157 - acc: 1.0000 - val_loss: 0.1401 - val_ac
c: 0.7720
Epoch 499/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0176 - acc: 0.9857 - val_loss: 0.1352 - val_ac
c: 0.7780
Epoch 500/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0178 - acc: 0.9857 - val_loss: 0.1338 - val_ac
c: 0.7760
Epoch 501/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0166 - acc: 0.9857 - val_loss: 0.1325 - val_ac
c: 0.7680
Epoch 502/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0172 - acc: 0.9857 - val_loss: 0.1317 - val_ac
c: 0.7720
Epoch 503/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0188 - acc: 0.9571 - val_loss: 0.1302 - val_ac
c: 0.7840
Epoch 504/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0174 - acc: 0.9786 - val_loss: 0.1303 - val_ac
c: 0.7840
Epoch 505/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0172 - acc: 0.9786 - val_loss: 0.1312 - val_ac
c: 0.7840
Epoch 506/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0181 - acc: 0.9786 - val_loss: 0.1353 - val_ac
c: 0.7880
Epoch 507/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0193 - acc: 0.9714 - val_loss: 0.1389 - val_ac
c: 0.7820
Epoch 508/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0162 - acc: 0.9929 - val_loss: 0.1396 - val_ac
c: 0.7780
Epoch 509/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0159 - acc: 0.9929 - val_loss: 0.1407 - val_ac
c: 0.7760
Epoch 510/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0171 - acc: 0.9786 - val_loss: 0.1406 - val_ac
c: 0.7700
Epoch 511/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0173 - acc: 0.9929 - val_loss: 0.1393 - val_ac
c: 0.7700
Epoch 512/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0161 - acc: 1.0000 - val_loss: 0.1386 - val_ac
c: 0.7680
Epoch 513/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0177 - acc: 0.9786 - val_loss: 0.1381 - val_ac
c: 0.7760
Epoch 514/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0166 - acc: 0.9786 - val_loss: 0.1365 - val_ac
c: 0.7760
Epoch 515/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0166 - acc: 0.9857 - val_loss: 0.1360 - val_ac
c: 0.7760
Epoch 516/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0165 - acc: 0.9929 - val_loss: 0.1361 - val_ac
c: 0.7860
Epoch 517/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0149 - acc: 0.9857 - val_loss: 0.1364 - val_ac
c: 0.7780
Epoch 518/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0156 - acc: 0.9929 - val_loss: 0.1368 - val_ac
c: 0.7780
Epoch 519/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0177 - acc: 0.9714 - val_loss: 0.1365 - val_ac
c: 0.7740
Epoch 520/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0167 - acc: 0.9857 - val_loss: 0.1363 - val_ac
c: 0.7700
```

```
Epoch 521/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0187 - acc: 0.9643 - val_loss: 0.1356 - val_ac
c: 0.7700
Epoch 522/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0160 - acc: 0.9786 - val_loss: 0.1375 - val_ac
c: 0.7680
Epoch 523/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0155 - acc: 1.0000 - val_loss: 0.1399 - val_ac
c: 0.7700
Epoch 524/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0172 - acc: 0.9714 - val_loss: 0.1426 - val_ac
c: 0.7660
Epoch 525/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0158 - acc: 0.9857 - val_loss: 0.1431 - val_ac
c: 0.7700
Epoch 526/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0158 - acc: 0.9714 - val_loss: 0.1435 - val_ac
c: 0.7700
Epoch 527/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0165 - acc: 0.9786 - val_loss: 0.1445 - val_ac
c: 0.7680
Epoch 528/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0172 - acc: 0.9643 - val_loss: 0.1437 - val_ac
c: 0.7600
Epoch 529/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0166 - acc: 0.9929 - val_loss: 0.1443 - val_ac
c: 0.7560
Epoch 530/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0172 - acc: 0.9643 - val_loss: 0.1424 - val_ac
c: 0.7580
Epoch 531/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0146 - acc: 0.9857 - val_loss: 0.1392 - val_ac
c: 0.7540
Epoch 532/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0153 - acc: 1.0000 - val_loss: 0.1349 - val_ac
c: 0.7620
Epoch 533/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0179 - acc: 0.9714 - val_loss: 0.1332 - val_ac
c: 0.7740
Epoch 534/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0169 - acc: 0.9643 - val_loss: 0.1335 - val_ac
c: 0.7780
Epoch 535/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0176 - acc: 0.9429 - val_loss: 0.1391 - val_ac
c: 0.7600
Epoch 536/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0178 - acc: 0.9786 - val_loss: 0.1441 - val_ac
c: 0.7520
Epoch 537/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0175 - acc: 0.9571 - val_loss: 0.1469 - val_ac
c: 0.7520
Epoch 538/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0170 - acc: 0.9714 - val_loss: 0.1469 - val_ac
c: 0.7500
Epoch 539/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0159 - acc: 0.9786 - val_loss: 0.1464 - val_ac
c: 0.7520
Epoch 540/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0178 - acc: 0.9929 - val_loss: 0.1445 - val_ac
c: 0.7520
Epoch 541/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0174 - acc: 0.9857 - val_loss: 0.1431 - val_ac
c: 0.7500
Epoch 542/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0179 - acc: 0.9786 - val_loss: 0.1411 - val_ac
c: 0.7560
Epoch 543/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0162 - acc: 0.9786 - val_loss: 0.1408 - val_ac
c: 0.7600
Epoch 544/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0167 - acc: 0.9857 - val_loss: 0.1424 - val_ac
```

```
c: 0.7540
Epoch 545/600
1/1 [==============================] - 0s 178ms/step - loss: 0.0168 - acc: 0.9714 - val_loss: 0.1464 - val_ac
c: 0.7500
Epoch 546/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0165 - acc: 0.9929 - val_loss: 0.1509 - val_ac
c: 0.7480
Epoch 547/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0184 - acc: 0.9786 - val_loss: 0.1504 - val_ac
c: 0.7500
Epoch 548/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0181 - acc: 0.9643 - val_loss: 0.1482 - val_ac
c: 0.7580
Epoch 549/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0163 - acc: 0.9857 - val_loss: 0.1432 - val_ac
c: 0.7680
Epoch 550/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0162 - acc: 0.9857 - val_loss: 0.1425 - val_ac
c: 0.7600
Epoch 551/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0173 - acc: 0.9857 - val_loss: 0.1407 - val_ac
c: 0.7600
Epoch 552/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0200 - acc: 0.9786 - val_loss: 0.1362 - val_ac
c: 0.7700
Epoch 553/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0173 - acc: 0.9857 - val_loss: 0.1327 - val_ac
c: 0.7660
Epoch 554/600
1/1 [==============================] - 0s 178ms/step - loss: 0.0181 - acc: 0.9786 - val_loss: 0.1300 - val_ac
c: 0.7740
Epoch 555/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0176 - acc: 0.9929 - val_loss: 0.1299 - val_ac
c: 0.7760
Epoch 556/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0156 - acc: 0.9929 - val_loss: 0.1323 - val_ac
c: 0.7720
Epoch 557/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0171 - acc: 0.9857 - val_loss: 0.1370 - val_ac
c: 0.7680
Epoch 558/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0178 - acc: 0.9714 - val_loss: 0.1425 - val_ac
c: 0.7600
Epoch 559/600
1/1 [==============================] - 0s 181ms/step - loss: 0.0167 - acc: 0.9786 - val_loss: 0.1458 - val_ac
c: 0.7520
Epoch 560/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0171 - acc: 0.9857 - val_loss: 0.1472 - val_ac
c: 0.7520
Epoch 561/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0179 - acc: 0.9643 - val_loss: 0.1463 - val_ac
c: 0.7520
Epoch 562/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0159 - acc: 0.9929 - val_loss: 0.1445 - val_ac
c: 0.7580
Epoch 563/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0177 - acc: 0.9714 - val_loss: 0.1408 - val_ac
c: 0.7760
Epoch 564/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0160 - acc: 0.9643 - val_loss: 0.1366 - val_ac
c: 0.7840
Epoch 565/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0171 - acc: 0.9714 - val_loss: 0.1334 - val_ac
c: 0.7820
Epoch 566/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0163 - acc: 0.9929 - val_loss: 0.1317 - val_ac
c: 0.7860
Epoch 567/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0168 - acc: 0.9786 - val_loss: 0.1302 - val_ac
c: 0.7880
Epoch 568/600
```

```
1/1 [==============================] - 0s 170ms/step - loss: 0.0184 - acc: 0.9714 - val_loss: 0.1318 - val_ac
c: 0.7900
Epoch 569/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0164 - acc: 0.9786 - val_loss: 0.1361 - val_ac
c: 0.7860
Epoch 570/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0170 - acc: 0.9786 - val_loss: 0.1407 - val_ac
c: 0.7820
Epoch 571/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0168 - acc: 0.9786 - val_loss: 0.1427 - val_ac
c: 0.7860
Epoch 572/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0166 - acc: 0.9857 - val_loss: 0.1424 - val_ac
c: 0.7840
Epoch 573/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0167 - acc: 0.9929 - val_loss: 0.1397 - val_ac
c: 0.7740
Epoch 574/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0175 - acc: 0.9643 - val_loss: 0.1378 - val_ac
c: 0.7600
Epoch 575/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0169 - acc: 0.9929 - val_loss: 0.1368 - val_ac
c: 0.7660
Epoch 576/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0158 - acc: 0.9857 - val_loss: 0.1376 - val_ac
c: 0.7760
Epoch 577/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0182 - acc: 0.9786 - val_loss: 0.1396 - val_ac
c: 0.7760
Epoch 578/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0158 - acc: 0.9857 - val_loss: 0.1429 - val_ac
c: 0.7700
Epoch 579/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0168 - acc: 0.9714 - val_loss: 0.1443 - val_ac
c: 0.7680
Epoch 580/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0186 - acc: 0.9714 - val_loss: 0.1474 - val_ac
c: 0.7640
Epoch 581/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0158 - acc: 0.9786 - val_loss: 0.1479 - val_ac
c: 0.7720
Epoch 582/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0177 - acc: 0.9714 - val_loss: 0.1432 - val_ac
c: 0.7640
Epoch 583/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0173 - acc: 0.9714 - val_loss: 0.1365 - val_ac
c: 0.7740
Epoch 584/600
1/1 [==============================] - 0s 186ms/step - loss: 0.0150 - acc: 1.0000 - val_loss: 0.1322 - val_ac
c: 0.7780
Epoch 585/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0173 - acc: 0.9786 - val_loss: 0.1304 - val_ac
c: 0.7900
Epoch 586/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0156 - acc: 0.9786 - val_loss: 0.1309 - val_ac
c: 0.7900
Epoch 587/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0158 - acc: 0.9857 - val_loss: 0.1324 - val_ac
c: 0.7800
Epoch 588/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0175 - acc: 0.9786 - val_loss: 0.1329 - val_ac
c: 0.7820
Epoch 589/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0162 - acc: 0.9714 - val_loss: 0.1402 - val_ac
c: 0.7780
Epoch 590/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0151 - acc: 0.9929 - val_loss: 0.1506 - val_ac
c: 0.7640
Epoch 591/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0163 - acc: 0.9857 - val_loss: 0.1576 - val_ac
c: 0.7440
```

```
Epoch 592/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0178 - acc: 0.9643 - val_loss: 0.1547 - val_ac
c: 0.7520
Epoch 593/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0171 - acc: 0.9786 - val_loss: 0.1481 - val_ac
c: 0.7680
Epoch 594/600
1/1 [==============================] - 0s 177ms/step - loss: 0.0186 - acc: 0.9714 - val_loss: 0.1418 - val_ac
c: 0.7620
Epoch 595/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0143 - acc: 1.0000 - val_loss: 0.1385 - val_ac
c: 0.7700
Epoch 596/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0163 - acc: 0.9643 - val_loss: 0.1376 - val_ac
c: 0.7640
Epoch 597/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0164 - acc: 0.9929 - val_loss: 0.1384 - val_ac
c: 0.7740
Epoch 598/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0168 - acc: 0.9714 - val_loss: 0.1386 - val_ac
c: 0.7780
Epoch 599/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0151 - acc: 0.9929 - val_loss: 0.1402 - val_ac
c: 0.7800
Epoch 600/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0177 - acc: 0.9643 - val_loss: 0.1419 - val_ac
c: 0.7700
```

Out[ ]: <tensorflow.python.keras.callbacks.History at 0x2b8ba157f08>

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       0.64      0.82      0.72       114
    Genetic_Algorithms       0.85      0.87      0.86       156
       Neural_Networks       0.79      0.67      0.72       290
 Probabilistic_Methods       0.80      0.65      0.72       172
Reinforcement_Learning       0.81      0.72      0.76        85
         Rule_Learning       0.50      0.77      0.61        60
                Theory       0.51      0.59      0.55       123

              accuracy                           0.71      1000
             macro avg       0.70      0.73      0.71      1000
          weighted avg       0.73      0.71      0.72      1000
```

Get hidden layer representation for GCN

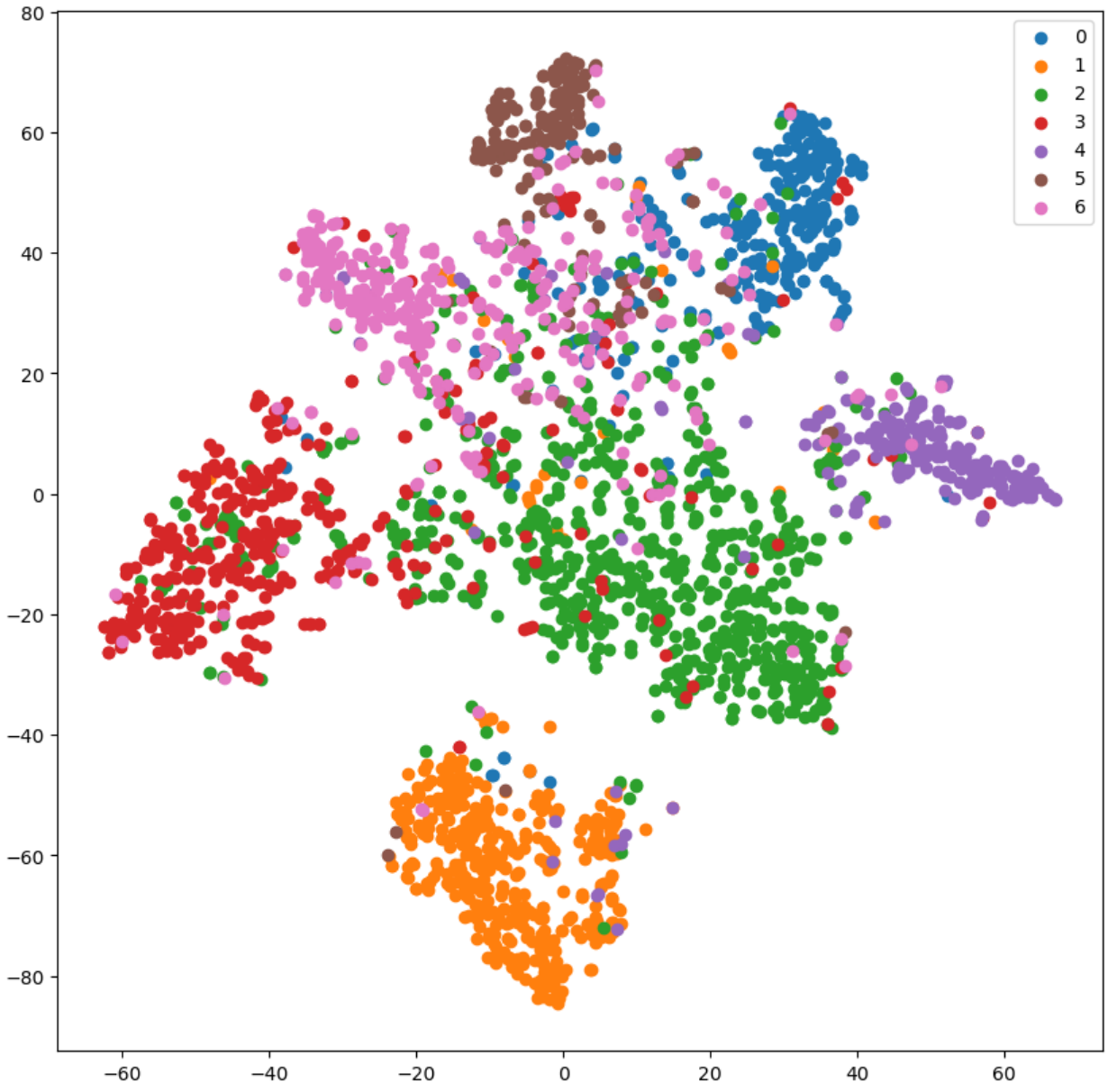
In [ ]:
```
layer_outputs = [layer.output for layer in model.layers]
activation_model = Model(inputs=model.input, outputs=layer_outputs)
activations = activation_model.predict([X,A],batch_size=N)

#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 = 300
optimizer = Adam(lr=1e-2)
l2_reg = 5e-4
epochs = 600

#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 1/600
1/1 [==============================] - 0s 242ms/step - loss: 0.2191 - acc: 0.1286 - val_loss: 0.4353 - val_ac
c: 0.1760
Epoch 2/600
1/1 [==============================] - ETA: 0s - loss: 0.1747 - acc: 0.3571WARNING:tensorflow:Method (on_trai
n_batch_end) is slow compared to the batch update (0.141064). Check your callbacks.
1/1 [==============================] - 0s 177ms/step - loss: 0.1747 - acc: 0.3571 - val_loss: 0.4006 - val_ac
c: 0.3220
Epoch 3/600
1/1 [==============================] - 0s 187ms/step - loss: 0.1422 - acc: 0.4857 - val_loss: 0.3715 - val_ac
c: 0.4520
Epoch 4/600
1/1 [==============================] - 0s 199ms/step - loss: 0.1142 - acc: 0.6286 - val_loss: 0.3443 - val_ac
c: 0.4800
Epoch 5/600
1/1 [==============================] - 0s 212ms/step - loss: 0.0893 - acc: 0.7929 - val_loss: 0.3172 - val_ac
c: 0.5080
Epoch 6/600
1/1 [==============================] - 0s 246ms/step - loss: 0.0676 - acc: 0.8714 - val_loss: 0.2885 - val_ac
c: 0.5440
Epoch 7/600
1/1 [==============================] - 0s 236ms/step - loss: 0.0558 - acc: 0.9071 - val_loss: 0.2656 - val_ac
c: 0.5640
Epoch 8/600
1/1 [==============================] - 0s 231ms/step - loss: 0.0452 - acc: 0.9500 - val_loss: 0.2603 - val_ac
c: 0.5760
Epoch 9/600
1/1 [==============================] - 0s 324ms/step - loss: 0.0443 - acc: 0.9500 - val_loss: 0.2729 - val_ac
c: 0.5740
Epoch 10/600
1/1 [==============================] - 0s 261ms/step - loss: 0.0443 - acc: 0.9643 - val_loss: 0.2900 - val_ac
c: 0.5640
Epoch 11/600
1/1 [==============================] - 0s 215ms/step - loss: 0.0438 - acc: 0.9643 - val_loss: 0.3165 - val_ac
c: 0.5480
Epoch 12/600
1/1 [==============================] - 0s 218ms/step - loss: 0.0413 - acc: 0.9857 - val_loss: 0.3470 - val_ac
c: 0.5340
Epoch 13/600
1/1 [==============================] - 0s 212ms/step - loss: 0.0416 - acc: 0.9857 - val_loss: 0.3656 - val_ac
c: 0.5360
Epoch 14/600
1/1 [==============================] - 0s 217ms/step - loss: 0.0386 - acc: 1.0000 - val_loss: 0.3916 - val_ac
c: 0.5200
Epoch 15/600
1/1 [==============================] - 0s 234ms/step - loss: 0.0363 - acc: 1.0000 - val_loss: 0.4109 - val_ac
c: 0.5100
Epoch 16/600
1/1 [==============================] - 0s 239ms/step - loss: 0.0356 - acc: 0.9786 - val_loss: 0.4094 - val_ac
c: 0.5180
Epoch 17/600
1/1 [==============================] - 0s 257ms/step - loss: 0.0328 - acc: 0.9857 - val_loss: 0.4127 - val_ac
c: 0.5160
Epoch 18/600
1/1 [==============================] - 0s 252ms/step - loss: 0.0309 - acc: 0.9857 - val_loss: 0.4065 - val_ac
c: 0.5260
Epoch 19/600
1/1 [==============================] - 0s 250ms/step - loss: 0.0268 - acc: 1.0000 - val_loss: 0.4015 - val_ac
c: 0.5300
Epoch 20/600
1/1 [==============================] - 0s 263ms/step - loss: 0.0256 - acc: 0.9857 - val_loss: 0.3983 - val_ac
c: 0.5200
Epoch 21/600
1/1 [==============================] - 0s 251ms/step - loss: 0.0232 - acc: 0.9929 - val_loss: 0.4013 - val_ac
c: 0.4980
Epoch 22/600
1/1 [==============================] - 0s 220ms/step - loss: 0.0223 - acc: 0.9857 - val_loss: 0.4072 - val_ac
c: 0.4920
Epoch 23/600
1/1 [==============================] - 0s 230ms/step - loss: 0.0229 - acc: 0.9786 - val_loss: 0.3965 - val_ac
c: 0.5040
```

```
Epoch 24/600
1/1 [==============================] - 0s 260ms/step - loss: 0.0216 - acc: 0.9857 - val_loss: 0.3871 - val_ac
c: 0.5140
Epoch 25/600
1/1 [==============================] - 0s 254ms/step - loss: 0.0216 - acc: 0.9786 - val_loss: 0.3806 - val_ac
c: 0.5320
Epoch 26/600
1/1 [==============================] - 0s 227ms/step - loss: 0.0214 - acc: 0.9786 - val_loss: 0.3871 - val_ac
c: 0.5320
Epoch 27/600
1/1 [==============================] - 0s 220ms/step - loss: 0.0225 - acc: 0.9857 - val_loss: 0.3836 - val_ac
c: 0.5180
Epoch 28/600
1/1 [==============================] - 0s 219ms/step - loss: 0.0211 - acc: 0.9786 - val_loss: 0.3670 - val_ac
c: 0.5220
Epoch 29/600
1/1 [==============================] - 0s 209ms/step - loss: 0.0220 - acc: 0.9786 - val_loss: 0.3633 - val_ac
c: 0.5200
Epoch 30/600
1/1 [==============================] - 0s 233ms/step - loss: 0.0205 - acc: 0.9786 - val_loss: 0.3645 - val_ac
c: 0.5100
Epoch 31/600
1/1 [==============================] - 0s 266ms/step - loss: 0.0232 - acc: 0.9714 - val_loss: 0.3677 - val_ac
c: 0.4960
Epoch 32/600
1/1 [==============================] - 0s 227ms/step - loss: 0.0195 - acc: 1.0000 - val_loss: 0.3665 - val_ac
c: 0.4680
Epoch 33/600
1/1 [==============================] - 0s 215ms/step - loss: 0.0207 - acc: 0.9929 - val_loss: 0.3608 - val_ac
c: 0.4740
Epoch 34/600
1/1 [==============================] - 0s 230ms/step - loss: 0.0201 - acc: 0.9929 - val_loss: 0.3546 - val_ac
c: 0.4840
Epoch 35/600
1/1 [==============================] - 0s 216ms/step - loss: 0.0224 - acc: 0.9786 - val_loss: 0.3464 - val_ac
c: 0.4960
Epoch 36/600
1/1 [==============================] - 0s 218ms/step - loss: 0.0208 - acc: 0.9929 - val_loss: 0.3386 - val_ac
c: 0.5180
Epoch 37/600
1/1 [==============================] - 0s 192ms/step - loss: 0.0220 - acc: 0.9929 - val_loss: 0.3360 - val_ac
c: 0.5240
Epoch 38/600
1/1 [==============================] - 0s 177ms/step - loss: 0.0221 - acc: 0.9929 - val_loss: 0.3371 - val_ac
c: 0.5300
Epoch 39/600
1/1 [==============================] - 0s 177ms/step - loss: 0.0205 - acc: 1.0000 - val_loss: 0.3394 - val_ac
c: 0.5280
Epoch 40/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0214 - acc: 0.9929 - val_loss: 0.3402 - val_ac
c: 0.5240
Epoch 41/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0206 - acc: 0.9929 - val_loss: 0.3387 - val_ac
c: 0.5160
Epoch 42/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0218 - acc: 0.9786 - val_loss: 0.3428 - val_ac
c: 0.5080
Epoch 43/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0195 - acc: 1.0000 - val_loss: 0.3462 - val_ac
c: 0.5220
Epoch 44/600
1/1 [==============================] - 0s 179ms/step - loss: 0.0204 - acc: 0.9857 - val_loss: 0.3562 - val_ac
c: 0.5120
Epoch 45/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0197 - acc: 0.9929 - val_loss: 0.3674 - val_ac
c: 0.5020
Epoch 46/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0206 - acc: 0.9929 - val_loss: 0.3690 - val_ac
c: 0.5080
Epoch 47/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0183 - acc: 1.0000 - val_loss: 0.3723 - val_ac
```

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c: 0.5060
Epoch 48/600
1/1 [==============================] - 0s 193ms/step - loss: 0.0187 - acc: 0.9857 - val_loss: 0.3764 - val_ac
c: 0.5040
Epoch 49/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0187 - acc: 0.9857 - val_loss: 0.3701 - val_ac
c: 0.5060
Epoch 50/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0195 - acc: 0.9857 - val_loss: 0.3619 - val_ac
c: 0.5080
Epoch 51/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0181 - acc: 0.9857 - val_loss: 0.3510 - val_ac
c: 0.5120
Epoch 52/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0167 - acc: 1.0000 - val_loss: 0.3439 - val_ac
c: 0.5280
Epoch 53/600
1/1 [==============================] - 0s 176ms/step - loss: 0.0173 - acc: 0.9929 - val_loss: 0.3404 - val_ac
c: 0.5360
Epoch 54/600
1/1 [==============================] - 0s 179ms/step - loss: 0.0176 - acc: 0.9929 - val_loss: 0.3411 - val_ac
c: 0.5300
Epoch 55/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0178 - acc: 0.9857 - val_loss: 0.3493 - val_ac
c: 0.5160
Epoch 56/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0173 - acc: 0.9929 - val_loss: 0.3549 - val_ac
c: 0.5160
Epoch 57/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0172 - acc: 0.9857 - val_loss: 0.3650 - val_ac
c: 0.5240
Epoch 58/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0201 - acc: 0.9714 - val_loss: 0.3705 - val_ac
c: 0.5180
Epoch 59/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0173 - acc: 1.0000 - val_loss: 0.3699 - val_ac
c: 0.5060
Epoch 60/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0191 - acc: 0.9857 - val_loss: 0.3714 - val_ac
c: 0.5160
Epoch 61/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0171 - acc: 0.9929 - val_loss: 0.3649 - val_ac
c: 0.5260
Epoch 62/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0168 - acc: 1.0000 - val_loss: 0.3624 - val_ac
c: 0.5140
Epoch 63/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0182 - acc: 0.9857 - val_loss: 0.3661 - val_ac
c: 0.5060
Epoch 64/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0180 - acc: 1.0000 - val_loss: 0.3723 - val_ac
c: 0.4980
Epoch 65/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0173 - acc: 1.0000 - val_loss: 0.3804 - val_ac
c: 0.4880
Epoch 66/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0188 - acc: 0.9857 - val_loss: 0.3801 - val_ac
c: 0.4960
Epoch 67/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0237 - acc: 0.9643 - val_loss: 0.3630 - val_ac
c: 0.5160
Epoch 68/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0176 - acc: 1.0000 - val_loss: 0.3546 - val_ac
c: 0.5240
Epoch 69/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0198 - acc: 0.9857 - val_loss: 0.3552 - val_ac
c: 0.5300
Epoch 70/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0204 - acc: 0.9857 - val_loss: 0.3603 - val_ac
c: 0.5160
Epoch 71/600
```

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1/1 [==============================] - 0s 168ms/step - loss: 0.0194 - acc: 0.9857 - val_loss: 0.3685 - val_ac
c: 0.5060
Epoch 72/600
1/1 [==============================] - 0s 184ms/step - loss: 0.0196 - acc: 0.9929 - val_loss: 0.3769 - val_ac
c: 0.5160
Epoch 73/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0197 - acc: 0.9929 - val_loss: 0.3816 - val_ac
c: 0.5080
Epoch 74/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0230 - acc: 0.9714 - val_loss: 0.4004 - val_ac
c: 0.4980
Epoch 75/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0222 - acc: 0.9786 - val_loss: 0.4025 - val_ac
c: 0.5100
Epoch 76/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0235 - acc: 0.9786 - val_loss: 0.3969 - val_ac
c: 0.5240
Epoch 77/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0213 - acc: 0.9857 - val_loss: 0.3861 - val_ac
c: 0.5220
Epoch 78/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0225 - acc: 0.9786 - val_loss: 0.3729 - val_ac
c: 0.5280
Epoch 79/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0225 - acc: 0.9929 - val_loss: 0.3648 - val_ac
c: 0.5420
Epoch 80/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0259 - acc: 0.9714 - val_loss: 0.3669 - val_ac
c: 0.5400
Epoch 81/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0234 - acc: 1.0000 - val_loss: 0.3714 - val_ac
c: 0.5400
Epoch 82/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0251 - acc: 0.9857 - val_loss: 0.3866 - val_ac
c: 0.5260
Epoch 83/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0257 - acc: 0.9857 - val_loss: 0.3978 - val_ac
c: 0.5200
Epoch 84/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0264 - acc: 0.9857 - val_loss: 0.4148 - val_ac
c: 0.5020
Epoch 85/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0289 - acc: 0.9714 - val_loss: 0.4222 - val_ac
c: 0.4840
Epoch 86/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0290 - acc: 0.9786 - val_loss: 0.4308 - val_ac
c: 0.4920
Epoch 87/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0272 - acc: 0.9857 - val_loss: 0.4393 - val_ac
c: 0.4900
Epoch 88/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0259 - acc: 1.0000 - val_loss: 0.4537 - val_ac
c: 0.4880
Epoch 89/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0282 - acc: 0.9786 - val_loss: 0.4574 - val_ac
c: 0.4780
Epoch 90/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0263 - acc: 1.0000 - val_loss: 0.4648 - val_ac
c: 0.4780
Epoch 91/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0276 - acc: 0.9857 - val_loss: 0.4736 - val_ac
c: 0.4780
Epoch 92/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0284 - acc: 0.9857 - val_loss: 0.4782 - val_ac
c: 0.4760
Epoch 93/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0309 - acc: 0.9643 - val_loss: 0.4723 - val_ac
c: 0.4760
Epoch 94/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0293 - acc: 0.9857 - val_loss: 0.4567 - val_ac
c: 0.4960
```

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Epoch 95/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0284 - acc: 0.9786 - val_loss: 0.4337 - val_ac
c: 0.5220
Epoch 96/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0285 - acc: 0.9929 - val_loss: 0.4298 - val_ac
c: 0.5080
Epoch 97/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0314 - acc: 0.9714 - val_loss: 0.4442 - val_ac
c: 0.5060
Epoch 98/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0311 - acc: 0.9643 - val_loss: 0.4507 - val_ac
c: 0.5040
Epoch 99/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0296 - acc: 0.9857 - val_loss: 0.4500 - val_ac
c: 0.5080
Epoch 100/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0313 - acc: 0.9857 - val_loss: 0.4369 - val_ac
c: 0.5180
Epoch 101/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0305 - acc: 0.9786 - val_loss: 0.4251 - val_ac
c: 0.5240
Epoch 102/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0312 - acc: 0.9714 - val_loss: 0.4087 - val_ac
c: 0.5320
Epoch 103/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0337 - acc: 0.9714 - val_loss: 0.3978 - val_ac
c: 0.5400
Epoch 104/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0342 - acc: 0.9714 - val_loss: 0.4006 - val_ac
c: 0.5360
Epoch 105/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0302 - acc: 0.9786 - val_loss: 0.4083 - val_ac
c: 0.5300
Epoch 106/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0319 - acc: 0.9643 - val_loss: 0.4282 - val_ac
c: 0.5200
Epoch 107/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0321 - acc: 0.9857 - val_loss: 0.4268 - val_ac
c: 0.5220
Epoch 108/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0348 - acc: 0.9643 - val_loss: 0.4181 - val_ac
c: 0.5160
Epoch 109/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0316 - acc: 0.9929 - val_loss: 0.4042 - val_ac
c: 0.5160
Epoch 110/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0326 - acc: 0.9929 - val_loss: 0.3951 - val_ac
c: 0.5080
Epoch 111/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0332 - acc: 0.9857 - val_loss: 0.3883 - val_ac
c: 0.5000
Epoch 112/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0351 - acc: 0.9714 - val_loss: 0.3818 - val_ac
c: 0.5040
Epoch 113/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0320 - acc: 0.9929 - val_loss: 0.3818 - val_ac
c: 0.5000
Epoch 114/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0324 - acc: 0.9857 - val_loss: 0.3816 - val_ac
c: 0.5140
Epoch 115/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0347 - acc: 0.9786 - val_loss: 0.3828 - val_ac
c: 0.4980
Epoch 116/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0360 - acc: 0.9714 - val_loss: 0.3816 - val_ac
c: 0.5000
Epoch 117/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0330 - acc: 0.9857 - val_loss: 0.3735 - val_ac
c: 0.5160
Epoch 118/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0348 - acc: 0.9643 - val_loss: 0.3755 - val_ac
```

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c: 0.5320
Epoch 119/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0325 - acc: 0.9857 - val_loss: 0.3765 - val_ac
c: 0.5420
Epoch 120/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0374 - acc: 0.9714 - val_loss: 0.3886 - val_ac
c: 0.5380
Epoch 121/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0333 - acc: 0.9857 - val_loss: 0.3968 - val_ac
c: 0.5220
Epoch 122/600
1/1 [==============================] - 0s 204ms/step - loss: 0.0332 - acc: 0.9857 - val_loss: 0.3953 - val_ac
c: 0.5120
Epoch 123/600
1/1 [==============================] - 0s 194ms/step - loss: 0.0316 - acc: 0.9929 - val_loss: 0.3886 - val_ac
c: 0.5140
Epoch 124/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0346 - acc: 0.9500 - val_loss: 0.3742 - val_ac
c: 0.5080
Epoch 125/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0325 - acc: 0.9857 - val_loss: 0.3641 - val_ac
c: 0.5040
Epoch 126/600
1/1 [==============================] - 0s 207ms/step - loss: 0.0328 - acc: 0.9714 - val_loss: 0.3530 - val_ac
c: 0.5040
Epoch 127/600
1/1 [==============================] - 0s 181ms/step - loss: 0.0306 - acc: 0.9857 - val_loss: 0.3479 - val_ac
c: 0.5160
Epoch 128/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0298 - acc: 0.9929 - val_loss: 0.3447 - val_ac
c: 0.5140
Epoch 129/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0312 - acc: 0.9714 - val_loss: 0.3431 - val_ac
c: 0.5300
Epoch 130/600
1/1 [==============================] - 0s 272ms/step - loss: 0.0303 - acc: 0.9857 - val_loss: 0.3443 - val_ac
c: 0.5300
Epoch 131/600
1/1 [==============================] - 0s 209ms/step - loss: 0.0339 - acc: 0.9643 - val_loss: 0.3502 - val_ac
c: 0.5300
Epoch 132/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0326 - acc: 0.9786 - val_loss: 0.3562 - val_ac
c: 0.5180
Epoch 133/600
1/1 [==============================] - 0s 179ms/step - loss: 0.0294 - acc: 0.9929 - val_loss: 0.3678 - val_ac
c: 0.4960
Epoch 134/600
1/1 [==============================] - 0s 202ms/step - loss: 0.0309 - acc: 0.9786 - val_loss: 0.3757 - val_ac
c: 0.4860
Epoch 135/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0311 - acc: 0.9714 - val_loss: 0.3830 - val_ac
c: 0.4840
Epoch 136/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0335 - acc: 0.9714 - val_loss: 0.3895 - val_ac
c: 0.4920
Epoch 137/600
1/1 [==============================] - 0s 191ms/step - loss: 0.0295 - acc: 0.9929 - val_loss: 0.3986 - val_ac
c: 0.4820
Epoch 138/600
1/1 [==============================] - 0s 202ms/step - loss: 0.0289 - acc: 0.9929 - val_loss: 0.4099 - val_ac
c: 0.4840
Epoch 139/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0278 - acc: 1.0000 - val_loss: 0.4178 - val_ac
c: 0.4660
Epoch 140/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0290 - acc: 0.9857 - val_loss: 0.4194 - val_ac
c: 0.4660
Epoch 141/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0283 - acc: 0.9929 - val_loss: 0.4162 - val_ac
c: 0.4780
Epoch 142/600
```

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1/1 [==============================] - 0s 165ms/step - loss: 0.0305 - acc: 0.9643 - val_loss: 0.3967 - val_ac
c: 0.5020
Epoch 143/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0290 - acc: 0.9786 - val_loss: 0.3757 - val_ac
c: 0.5320
Epoch 144/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0289 - acc: 0.9857 - val_loss: 0.3655 - val_ac
c: 0.5480
Epoch 145/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0289 - acc: 0.9929 - val_loss: 0.3663 - val_ac
c: 0.5500
Epoch 146/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0338 - acc: 0.9714 - val_loss: 0.3695 - val_ac
c: 0.5500
Epoch 147/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0302 - acc: 0.9571 - val_loss: 0.3751 - val_ac
c: 0.5540
Epoch 148/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0277 - acc: 0.9786 - val_loss: 0.3849 - val_ac
c: 0.5420
Epoch 149/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0301 - acc: 0.9786 - val_loss: 0.4003 - val_ac
c: 0.5320
Epoch 150/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0303 - acc: 0.9714 - val_loss: 0.4136 - val_ac
c: 0.5040
Epoch 151/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0301 - acc: 0.9786 - val_loss: 0.4180 - val_ac
c: 0.4900
Epoch 152/600
1/1 [==============================] - 0s 191ms/step - loss: 0.0276 - acc: 1.0000 - val_loss: 0.4186 - val_ac
c: 0.4860
Epoch 153/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0297 - acc: 0.9857 - val_loss: 0.4186 - val_ac
c: 0.4800
Epoch 154/600
1/1 [==============================] - 0s 183ms/step - loss: 0.0314 - acc: 0.9714 - val_loss: 0.4087 - val_ac
c: 0.4980
Epoch 155/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0338 - acc: 0.9714 - val_loss: 0.3898 - val_ac
c: 0.5140
Epoch 156/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0325 - acc: 0.9643 - val_loss: 0.3791 - val_ac
c: 0.5180
Epoch 157/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0309 - acc: 0.9786 - val_loss: 0.3771 - val_ac
c: 0.5260
Epoch 158/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0290 - acc: 1.0000 - val_loss: 0.3833 - val_ac
c: 0.5180
Epoch 159/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0300 - acc: 0.9929 - val_loss: 0.3913 - val_ac
c: 0.5140
Epoch 160/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0321 - acc: 0.9857 - val_loss: 0.3990 - val_ac
c: 0.5120
Epoch 161/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0297 - acc: 0.9929 - val_loss: 0.4090 - val_ac
c: 0.4960
Epoch 162/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0319 - acc: 0.9714 - val_loss: 0.4273 - val_ac
c: 0.4900
Epoch 163/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0327 - acc: 0.9786 - val_loss: 0.4584 - val_ac
c: 0.4700
Epoch 164/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0301 - acc: 0.9929 - val_loss: 0.4812 - val_ac
c: 0.4500
Epoch 165/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0322 - acc: 0.9786 - val_loss: 0.4890 - val_ac
c: 0.4360
```

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Epoch 166/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0343 - acc: 0.9643 - val_loss: 0.4941 - val_ac
c: 0.4500
Epoch 167/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0319 - acc: 0.9714 - val_loss: 0.4933 - val_ac
c: 0.4440
Epoch 168/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0320 - acc: 0.9857 - val_loss: 0.4819 - val_ac
c: 0.4580
Epoch 169/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0369 - acc: 0.9714 - val_loss: 0.4562 - val_ac
c: 0.4800
Epoch 170/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0343 - acc: 0.9714 - val_loss: 0.4304 - val_ac
c: 0.4820
Epoch 171/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0351 - acc: 0.9786 - val_loss: 0.4160 - val_ac
c: 0.4940
Epoch 172/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0310 - acc: 0.9786 - val_loss: 0.4075 - val_ac
c: 0.5000
Epoch 173/600
1/1 [==============================] - 0s 187ms/step - loss: 0.0306 - acc: 0.9929 - val_loss: 0.4033 - val_ac
c: 0.5040
Epoch 174/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0319 - acc: 0.9786 - val_loss: 0.3980 - val_ac
c: 0.5020
Epoch 175/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0339 - acc: 0.9714 - val_loss: 0.3897 - val_ac
c: 0.5060
Epoch 176/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0353 - acc: 0.9714 - val_loss: 0.3841 - val_ac
c: 0.5160
Epoch 177/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0322 - acc: 0.9857 - val_loss: 0.3845 - val_ac
c: 0.5260
Epoch 178/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0334 - acc: 0.9786 - val_loss: 0.3947 - val_ac
c: 0.5180
Epoch 179/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0332 - acc: 0.9786 - val_loss: 0.4052 - val_ac
c: 0.5180
Epoch 180/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0312 - acc: 1.0000 - val_loss: 0.4136 - val_ac
c: 0.5200
Epoch 181/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0348 - acc: 0.9786 - val_loss: 0.4189 - val_ac
c: 0.5200
Epoch 182/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0317 - acc: 1.0000 - val_loss: 0.4246 - val_ac
c: 0.5240
Epoch 183/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0374 - acc: 0.9857 - val_loss: 0.4283 - val_ac
c: 0.5240
Epoch 184/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0418 - acc: 0.9286 - val_loss: 0.4249 - val_ac
c: 0.5060
Epoch 185/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0345 - acc: 0.9714 - val_loss: 0.4215 - val_ac
c: 0.4980
Epoch 186/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0326 - acc: 0.9857 - val_loss: 0.4184 - val_ac
c: 0.4920
Epoch 187/600
1/1 [==============================] - 0s 178ms/step - loss: 0.0358 - acc: 0.9857 - val_loss: 0.4183 - val_ac
c: 0.4820
Epoch 188/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0351 - acc: 0.9643 - val_loss: 0.4192 - val_ac
c: 0.4760
Epoch 189/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0333 - acc: 0.9714 - val_loss: 0.4217 - val_ac
```

```
c: 0.4680
Epoch 190/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0331 - acc: 0.9857 - val_loss: 0.4249 - val_ac
c: 0.4720
Epoch 191/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0337 - acc: 0.9786 - val_loss: 0.4334 - val_ac
c: 0.4720
Epoch 192/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0345 - acc: 0.9786 - val_loss: 0.4456 - val_ac
c: 0.4740
Epoch 193/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0379 - acc: 0.9571 - val_loss: 0.4555 - val_ac
c: 0.4800
Epoch 194/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0371 - acc: 0.9643 - val_loss: 0.4472 - val_ac
c: 0.4820
Epoch 195/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0329 - acc: 1.0000 - val_loss: 0.4340 - val_ac
c: 0.4880
Epoch 196/600
1/1 [==============================] - 0s 176ms/step - loss: 0.0380 - acc: 0.9714 - val_loss: 0.4040 - val_ac
c: 0.5040
Epoch 197/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0358 - acc: 0.9714 - val_loss: 0.3832 - val_ac
c: 0.5300
Epoch 198/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0360 - acc: 0.9714 - val_loss: 0.3715 - val_ac
c: 0.5400
Epoch 199/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0347 - acc: 0.9857 - val_loss: 0.3685 - val_ac
c: 0.5480
Epoch 200/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0431 - acc: 0.9643 - val_loss: 0.3695 - val_ac
c: 0.5580
Epoch 201/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0397 - acc: 0.9643 - val_loss: 0.3687 - val_ac
c: 0.5540
Epoch 202/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0357 - acc: 0.9714 - val_loss: 0.3696 - val_ac
c: 0.5540
Epoch 203/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0394 - acc: 0.9500 - val_loss: 0.3727 - val_ac
c: 0.5480
Epoch 204/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0410 - acc: 0.9571 - val_loss: 0.3700 - val_ac
c: 0.5540
Epoch 205/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0358 - acc: 0.9786 - val_loss: 0.3750 - val_ac
c: 0.5460
Epoch 206/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0368 - acc: 0.9786 - val_loss: 0.3857 - val_ac
c: 0.5260
Epoch 207/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0380 - acc: 0.9929 - val_loss: 0.3965 - val_ac
c: 0.5140
Epoch 208/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0399 - acc: 0.9643 - val_loss: 0.4071 - val_ac
c: 0.5060
Epoch 209/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0442 - acc: 0.9500 - val_loss: 0.4180 - val_ac
c: 0.5040
Epoch 210/600
1/1 [==============================] - 0s 177ms/step - loss: 0.0416 - acc: 0.9786 - val_loss: 0.4340 - val_ac
c: 0.4920
Epoch 211/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0398 - acc: 0.9857 - val_loss: 0.4512 - val_ac
c: 0.4640
Epoch 212/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0401 - acc: 0.9857 - val_loss: 0.4597 - val_ac
c: 0.4580
Epoch 213/600
```

```
1/1 [==============================] - 0s 169ms/step - loss: 0.0407 - acc: 0.9643 - val_loss: 0.4531 - val_ac
c: 0.4700
Epoch 214/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0401 - acc: 0.9714 - val_loss: 0.4363 - val_ac
c: 0.4940
Epoch 215/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0419 - acc: 0.9714 - val_loss: 0.4276 - val_ac
c: 0.5020
Epoch 216/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0436 - acc: 0.9643 - val_loss: 0.4235 - val_ac
c: 0.4960
Epoch 217/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0393 - acc: 0.9857 - val_loss: 0.4172 - val_ac
c: 0.5080
Epoch 218/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0428 - acc: 0.9643 - val_loss: 0.4134 - val_ac
c: 0.5020
Epoch 219/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0492 - acc: 0.9429 - val_loss: 0.3994 - val_ac
c: 0.5160
Epoch 220/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0434 - acc: 0.9500 - val_loss: 0.3872 - val_ac
c: 0.5100
Epoch 221/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0397 - acc: 0.9857 - val_loss: 0.3768 - val_ac
c: 0.5240
Epoch 222/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0436 - acc: 0.9714 - val_loss: 0.3763 - val_ac
c: 0.5420
Epoch 223/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0436 - acc: 0.9643 - val_loss: 0.3809 - val_ac
c: 0.5380
Epoch 224/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0434 - acc: 0.9500 - val_loss: 0.3882 - val_ac
c: 0.5420
Epoch 225/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0422 - acc: 0.9643 - val_loss: 0.3925 - val_ac
c: 0.5360
Epoch 226/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0456 - acc: 0.9571 - val_loss: 0.3820 - val_ac
c: 0.5420
Epoch 227/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0417 - acc: 0.9786 - val_loss: 0.3727 - val_ac
c: 0.5420
Epoch 228/600
1/1 [==============================] - 0s 181ms/step - loss: 0.0410 - acc: 0.9929 - val_loss: 0.3722 - val_ac
c: 0.5480
Epoch 229/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0426 - acc: 0.9714 - val_loss: 0.3708 - val_ac
c: 0.5420
Epoch 230/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0441 - acc: 0.9571 - val_loss: 0.3699 - val_ac
c: 0.5380
Epoch 231/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0453 - acc: 0.9714 - val_loss: 0.3783 - val_ac
c: 0.5360
Epoch 232/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0420 - acc: 0.9857 - val_loss: 0.3919 - val_ac
c: 0.5120
Epoch 233/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0481 - acc: 0.9500 - val_loss: 0.4080 - val_ac
c: 0.4940
Epoch 234/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0430 - acc: 0.9786 - val_loss: 0.4224 - val_ac
c: 0.4840
Epoch 235/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0504 - acc: 0.9500 - val_loss: 0.4336 - val_ac
c: 0.4780
Epoch 236/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0464 - acc: 0.9500 - val_loss: 0.4425 - val_ac
c: 0.4860
```

```
Epoch 237/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0462 - acc: 0.9786 - val_loss: 0.4430 - val_ac
c: 0.4820
Epoch 238/600
1/1 [==============================] - 0s 183ms/step - loss: 0.0418 - acc: 0.9786 - val_loss: 0.4407 - val_ac
c: 0.4820
Epoch 239/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0469 - acc: 0.9571 - val_loss: 0.4331 - val_ac
c: 0.4860
Epoch 240/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0437 - acc: 0.9643 - val_loss: 0.4190 - val_ac
c: 0.5000
Epoch 241/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0442 - acc: 0.9714 - val_loss: 0.4048 - val_ac
c: 0.5220
Epoch 242/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0467 - acc: 0.9643 - val_loss: 0.3917 - val_ac
c: 0.5320
Epoch 243/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0444 - acc: 0.9786 - val_loss: 0.3853 - val_ac
c: 0.5380
Epoch 244/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0445 - acc: 0.9714 - val_loss: 0.3838 - val_ac
c: 0.5460
Epoch 245/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0448 - acc: 0.9786 - val_loss: 0.3846 - val_ac
c: 0.5500
Epoch 246/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0474 - acc: 0.9643 - val_loss: 0.3852 - val_ac
c: 0.5440
Epoch 247/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0469 - acc: 0.9786 - val_loss: 0.3864 - val_ac
c: 0.5400
Epoch 248/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0458 - acc: 0.9786 - val_loss: 0.3891 - val_ac
c: 0.5420
Epoch 249/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0450 - acc: 0.9714 - val_loss: 0.3928 - val_ac
c: 0.5340
Epoch 250/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0454 - acc: 0.9786 - val_loss: 0.3970 - val_ac
c: 0.5300
Epoch 251/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0449 - acc: 0.9714 - val_loss: 0.4001 - val_ac
c: 0.5280
Epoch 252/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0462 - acc: 0.9786 - val_loss: 0.4077 - val_ac
c: 0.5260
Epoch 253/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0434 - acc: 0.9857 - val_loss: 0.4170 - val_ac
c: 0.5120
Epoch 254/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0456 - acc: 0.9857 - val_loss: 0.4276 - val_ac
c: 0.5120
Epoch 255/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0437 - acc: 0.9714 - val_loss: 0.4316 - val_ac
c: 0.5000
Epoch 256/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0450 - acc: 0.9571 - val_loss: 0.4336 - val_ac
c: 0.5060
Epoch 257/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0435 - acc: 0.9929 - val_loss: 0.4405 - val_ac
c: 0.4940
Epoch 258/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0407 - acc: 0.9857 - val_loss: 0.4414 - val_ac
c: 0.4860
Epoch 259/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0393 - acc: 0.9929 - val_loss: 0.4389 - val_ac
c: 0.4880
Epoch 260/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0458 - acc: 0.9571 - val_loss: 0.4257 - val_ac
```

```
c: 0.4980
Epoch 261/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0440 - acc: 0.9714 - val_loss: 0.4133 - val_ac
c: 0.5060
Epoch 262/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0413 - acc: 0.9714 - val_loss: 0.4083 - val_ac
c: 0.5020
Epoch 263/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0387 - acc: 0.9786 - val_loss: 0.4085 - val_ac
c: 0.4880
Epoch 264/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0418 - acc: 0.9643 - val_loss: 0.4105 - val_ac
c: 0.4880
Epoch 265/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0402 - acc: 0.9714 - val_loss: 0.4097 - val_ac
c: 0.4940
Epoch 266/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0353 - acc: 1.0000 - val_loss: 0.4095 - val_ac
c: 0.5040
Epoch 267/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0393 - acc: 0.9786 - val_loss: 0.4049 - val_ac
c: 0.5060
Epoch 268/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0373 - acc: 0.9786 - val_loss: 0.3988 - val_ac
c: 0.5120
Epoch 269/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0355 - acc: 0.9786 - val_loss: 0.3964 - val_ac
c: 0.5140
Epoch 270/600
1/1 [==============================] - 0s 174ms/step - loss: 0.0358 - acc: 0.9929 - val_loss: 0.3938 - val_ac
c: 0.5100
Epoch 271/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0374 - acc: 0.9857 - val_loss: 0.3915 - val_ac
c: 0.5160
Epoch 272/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0350 - acc: 0.9929 - val_loss: 0.3880 - val_ac
c: 0.5160
Epoch 273/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0351 - acc: 0.9714 - val_loss: 0.3876 - val_ac
c: 0.5260
Epoch 274/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0350 - acc: 0.9714 - val_loss: 0.3889 - val_ac
c: 0.5320
Epoch 275/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0333 - acc: 0.9786 - val_loss: 0.3934 - val_ac
c: 0.5240
Epoch 276/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0374 - acc: 0.9643 - val_loss: 0.3976 - val_ac
c: 0.5100
Epoch 277/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0349 - acc: 0.9643 - val_loss: 0.4016 - val_ac
c: 0.5100
Epoch 278/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0352 - acc: 0.9429 - val_loss: 0.4092 - val_ac
c: 0.5060
Epoch 279/600
1/1 [==============================] - 0s 175ms/step - loss: 0.0352 - acc: 0.9786 - val_loss: 0.4157 - val_ac
c: 0.4920
Epoch 280/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0317 - acc: 0.9714 - val_loss: 0.4281 - val_ac
c: 0.4700
Epoch 281/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0303 - acc: 0.9929 - val_loss: 0.4353 - val_ac
c: 0.4640
Epoch 282/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0319 - acc: 0.9643 - val_loss: 0.4404 - val_ac
c: 0.4420
Epoch 283/600
1/1 [==============================] - 0s 172ms/step - loss: 0.0322 - acc: 0.9929 - val_loss: 0.4412 - val_ac
c: 0.4340
Epoch 284/600
```

```
1/1 [==============================] - 0s 164ms/step - loss: 0.0322 - acc: 0.9786 - val_loss: 0.4373 - val_ac
c: 0.4440
Epoch 285/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0340 - acc: 0.9714 - val_loss: 0.4297 - val_ac
c: 0.4580
Epoch 286/600
1/1 [==============================] - 0s 165ms/step - loss: 0.0306 - acc: 0.9857 - val_loss: 0.4219 - val_ac
c: 0.4620
Epoch 287/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0296 - acc: 0.9929 - val_loss: 0.4156 - val_ac
c: 0.4700
Epoch 288/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0317 - acc: 0.9714 - val_loss: 0.4121 - val_ac
c: 0.4760
Epoch 289/600
1/1 [==============================] - 0s 173ms/step - loss: 0.0336 - acc: 0.9714 - val_loss: 0.4029 - val_ac
c: 0.4820
Epoch 290/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0334 - acc: 0.9714 - val_loss: 0.3961 - val_ac
c: 0.4760
Epoch 291/600
1/1 [==============================] - 0s 178ms/step - loss: 0.0290 - acc: 0.9929 - val_loss: 0.3879 - val_ac
c: 0.4900
Epoch 292/600
1/1 [==============================] - 0s 163ms/step - loss: 0.0288 - acc: 0.9929 - val_loss: 0.3818 - val_ac
c: 0.4980
Epoch 293/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0292 - acc: 0.9857 - val_loss: 0.3805 - val_ac
c: 0.4980
Epoch 294/600
1/1 [==============================] - 0s 160ms/step - loss: 0.0290 - acc: 1.0000 - val_loss: 0.3803 - val_ac
c: 0.4960
Epoch 295/600
1/1 [==============================] - 0s 162ms/step - loss: 0.0306 - acc: 0.9786 - val_loss: 0.3800 - val_ac
c: 0.5100
Epoch 296/600
1/1 [==============================] - 0s 164ms/step - loss: 0.0291 - acc: 0.9857 - val_loss: 0.3810 - val_ac
c: 0.5080
Epoch 297/600
1/1 [==============================] - 0s 166ms/step - loss: 0.0346 - acc: 0.9786 - val_loss: 0.3828 - val_ac
c: 0.5100
Epoch 298/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0283 - acc: 0.9786 - val_loss: 0.3889 - val_ac
c: 0.5020
Epoch 299/600
1/1 [==============================] - 0s 168ms/step - loss: 0.0328 - acc: 0.9786 - val_loss: 0.3923 - val_ac
c: 0.5100
Epoch 300/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0279 - acc: 0.9857 - val_loss: 0.3912 - val_ac
c: 0.5080
Epoch 301/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0315 - acc: 0.9786 - val_loss: 0.3978 - val_ac
c: 0.5060
Epoch 302/600
1/1 [==============================] - 0s 167ms/step - loss: 0.0313 - acc: 0.9643 - val_loss: 0.3994 - val_ac
c: 0.5060
Epoch 303/600
1/1 [==============================] - 0s 169ms/step - loss: 0.0303 - acc: 0.9857 - val_loss: 0.4083 - val_ac
c: 0.4960
Epoch 304/600
1/1 [==============================] - 0s 170ms/step - loss: 0.0325 - acc: 0.9714 - val_loss: 0.4159 - val_ac
c: 0.4880
Epoch 305/600
1/1 [==============================] - 0s 159ms/step - loss: 0.0307 - acc: 0.9857 - val_loss: 0.4151 - val_ac
c: 0.4960
Epoch 306/600
1/1 [==============================] - 0s 161ms/step - loss: 0.0327 - acc: 0.9643 - val_loss: 0.4132 - val_ac
c: 0.4960
Epoch 307/600
1/1 [==============================] - 0s 179ms/step - loss: 0.0311 - acc: 0.9643 - val_loss: 0.4157 - val_ac
c: 0.4940
```

```
Epoch 308/600
1/1 [==============================] - 0s 171ms/step - loss: 0.0343 - acc: 0.9643 - val_loss: 0.4261 - val_ac
c: 0.4640
```

Out[ ]: <tensorflow.python.keras.callbacks.History at 0x2b882c30308>

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

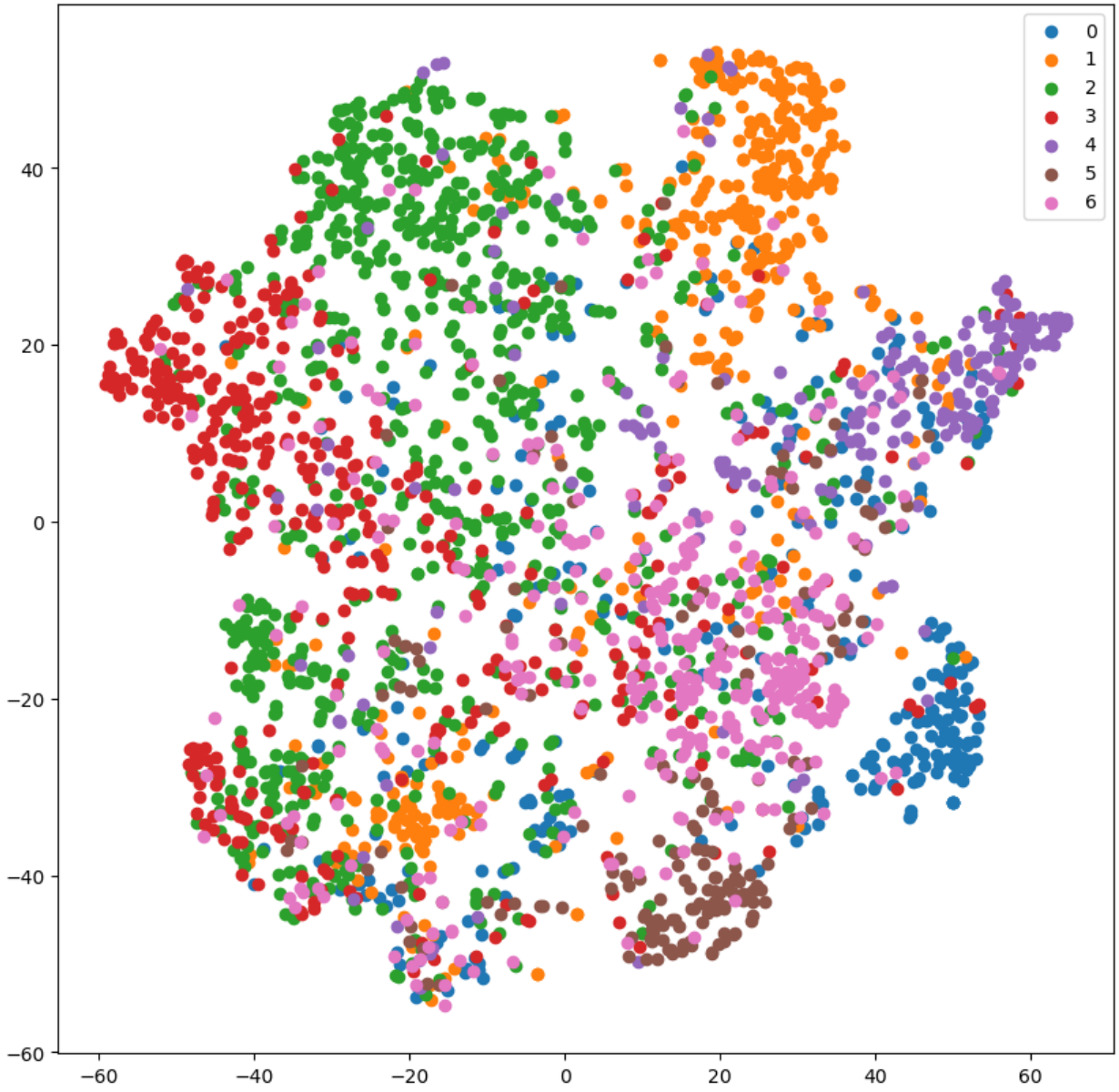
            Case_Based       0.50      0.51      0.50       114
    Genetic_Algorithms       0.71      0.75      0.73       156
       Neural_Networks       0.70      0.54      0.61       290
 Probabilistic_Methods       0.64      0.57      0.60       172
Reinforcement_Learning       0.44      0.55      0.49        85
         Rule_Learning       0.34      0.80      0.47        60
                Theory       0.50      0.37      0.43       123

              accuracy                           0.57      1000
             macro avg       0.55      0.58      0.55      1000
          weighted avg       0.60      0.57      0.57      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 ###
```