

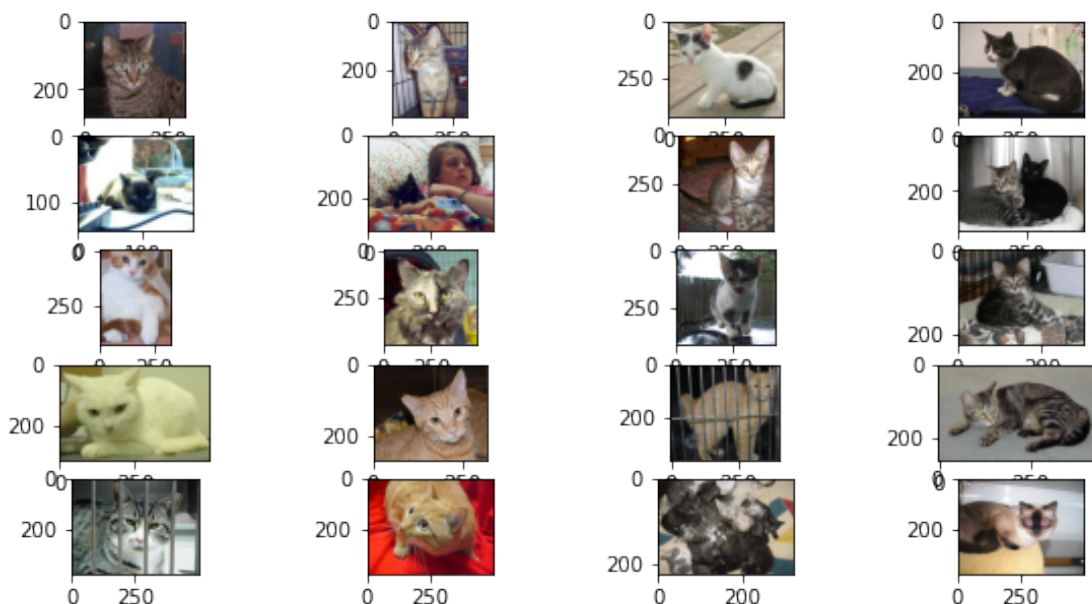
# pet\_classification

October 16, 2021

```
[1]: import matplotlib.pyplot as plt  
import numpy as np
```

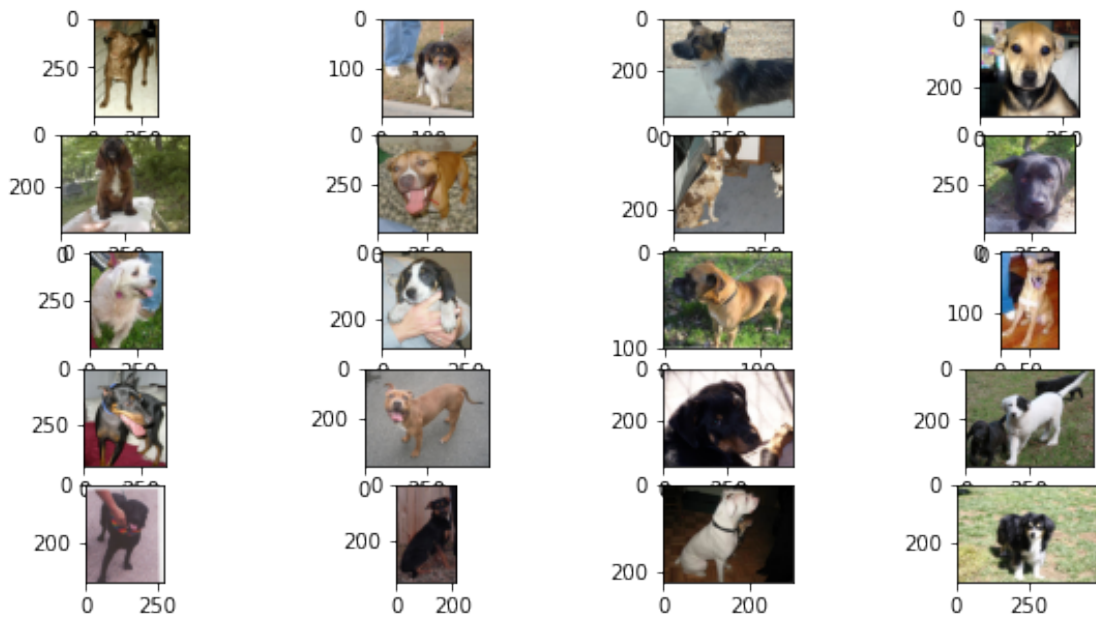
```
[2]: train_data_path = 'data/train/'
```

```
[6]: #sample cats images  
plt.figure(figsize=(10,5))  
for i in range(1,21):  
    plt.subplot(5, 4, i)  
    img = plt.imread(train_data_path+'cats/'+str(i)+'.jpg')  
    plt.imshow(img)
```



```
[7]: #sample dog images  
plt.figure(figsize=(10,5))  
for i in range(1,21):  
    plt.subplot(5, 4, i)  
    img = plt.imread(train_data_path+'dogs/'+str(i)+'.jpg')
```

```
plt.imshow(img)
```



## 0.1 Data Augmentation

- As images are of different sizes, resize all images to 224x224
- Dataset has less number of images i.e 20 cats and 20 dog images, will perform data augmentation such as Rotation, Shear, Horizontal Flip, Zoom.

```
[8]: img_size = 224
channels = 3
batch_size = 8
seed=99
```

```
[9]: from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

```
[16]: def show_generator_results(data_gen, cls, n, n_row, rescale):
    i=0
    for x in data_gen.flow_from_directory(train_data_path, batch_size=1,
    ↪ classes=[cls]):
        if i >= n:
            break

        if rescale:
            plt.subplot(n//n_row, n_row, i+1)
            plt.imshow(x[0][0])
```

```

else:
    plt.subplot(n//n_row, n_row, i+1)
    plt.imshow(x[0][0].astype('uint32'))
    i+=1

```

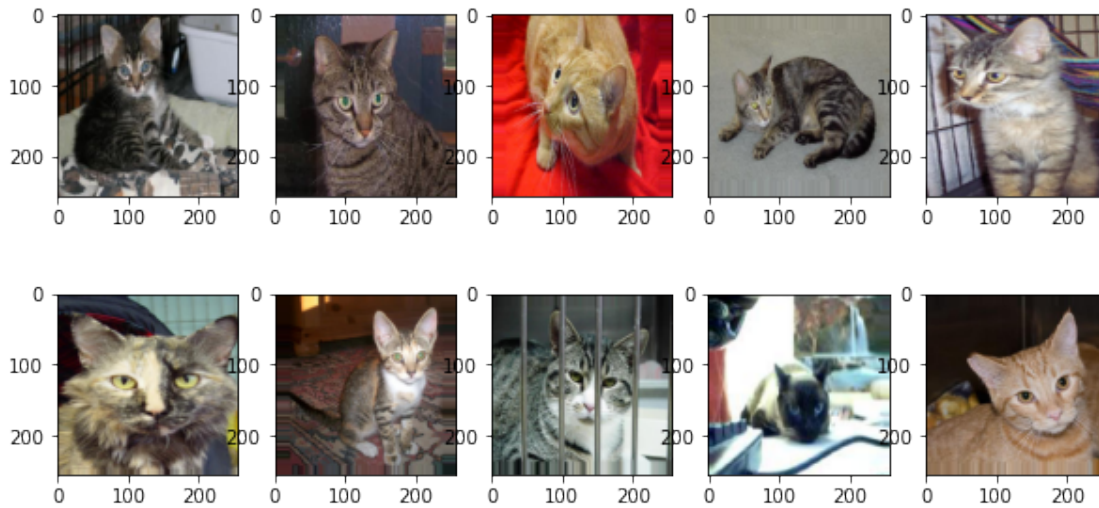
```

[19]: temp_data = ImageDataGenerator(zoom_range=0.2,)

plt.figure(figsize=(10,5))
show_generator_results(temp_data, 'cats', 10, 5, False)

```

Found 20 images belonging to 1 classes.



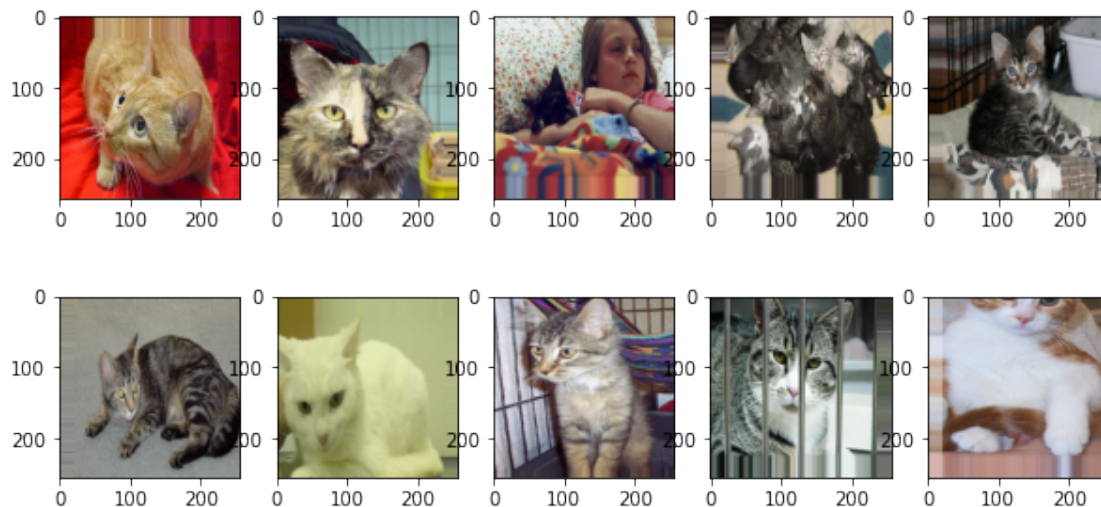
```

[21]: temp_data = ImageDataGenerator(height_shift_range=[-30,10],
                                     width_shift_range=[0,20])

plt.figure(figsize=(10,5))
show_generator_results(temp_data, 'cats', 10, 5, False)

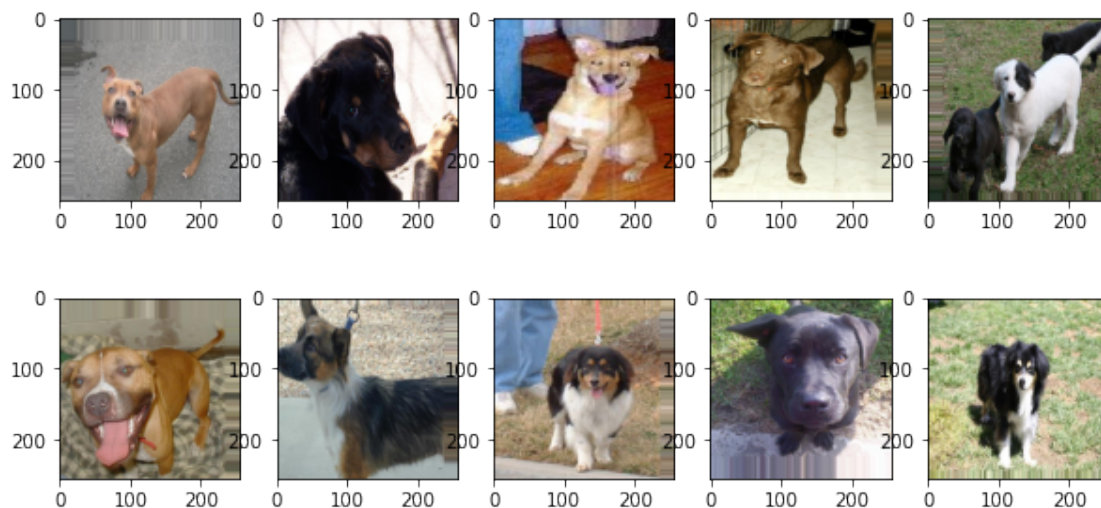
```

Found 20 images belonging to 1 classes.



```
[22]: plt.figure(figsize=(10,5))
      show_generator_results(temp_data, 'dogs', 10, 5, False)
```

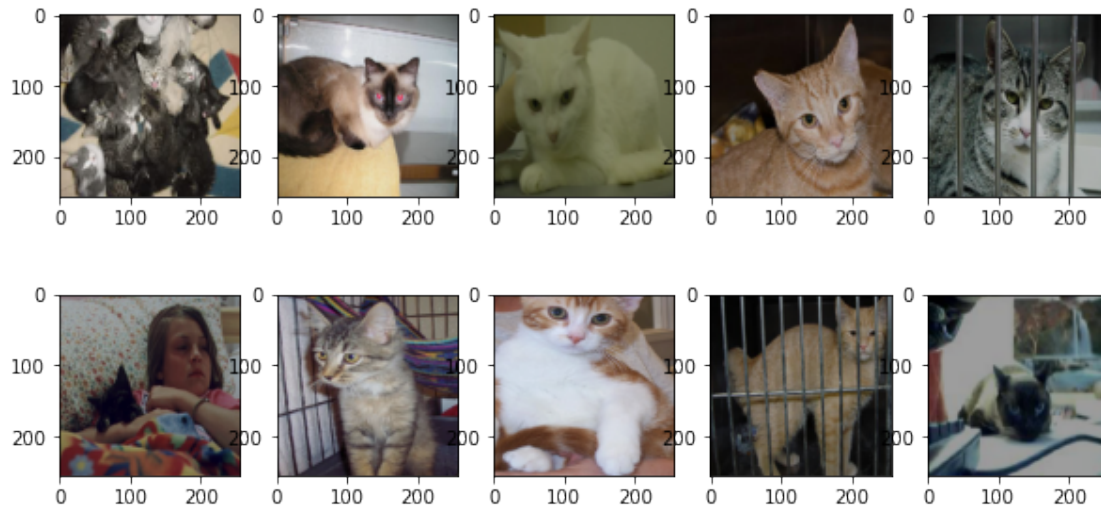
Found 20 images belonging to 1 classes.



```
[24]: temp_data = ImageDataGenerator(shear_range=0.2,
                                     brightness_range=[0.5,1])

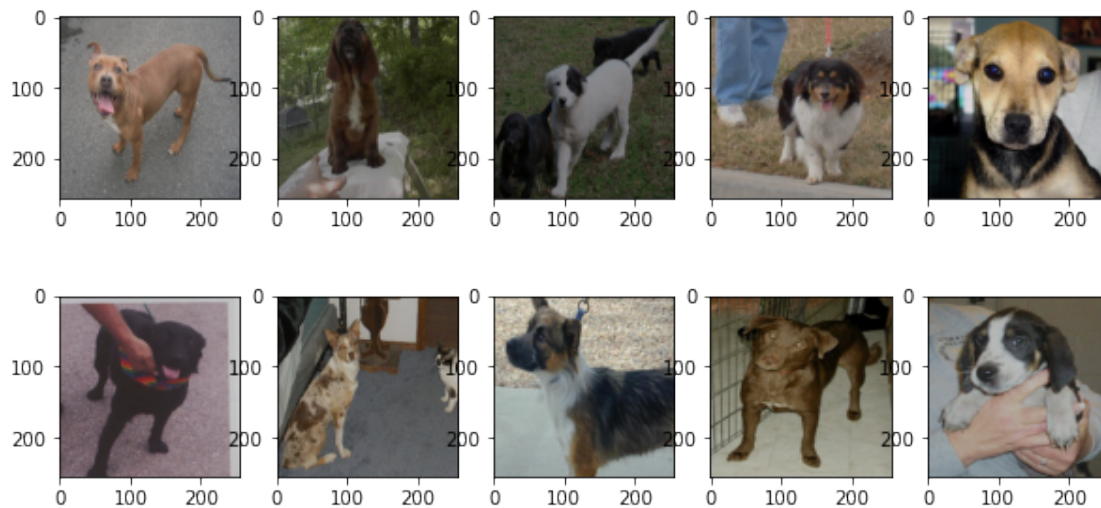
      plt.figure(figsize=(10,5))
      show_generator_results(temp_data, 'cats', 10, 5, False)
```

Found 20 images belonging to 1 classes.



```
[26]: plt.figure(figsize=(10,5))
      show_generator_results(temp_data, 'dogs', 10, 5, False)
```

Found 20 images belonging to 1 classes.



```
[27]: train_img_gen = ImageDataGenerator(
      rescale=1./255,
      shear_range=0.2,
      horizontal_flip=True,
      zoom_range=0.2,
      height_shift_range=[-30,10],
      width_shift_range=[0,20],
```



```

        brightness_range=[0.5,1],
    )

test_img_gen = ImageDataGenerator(rescale=1.0/255)

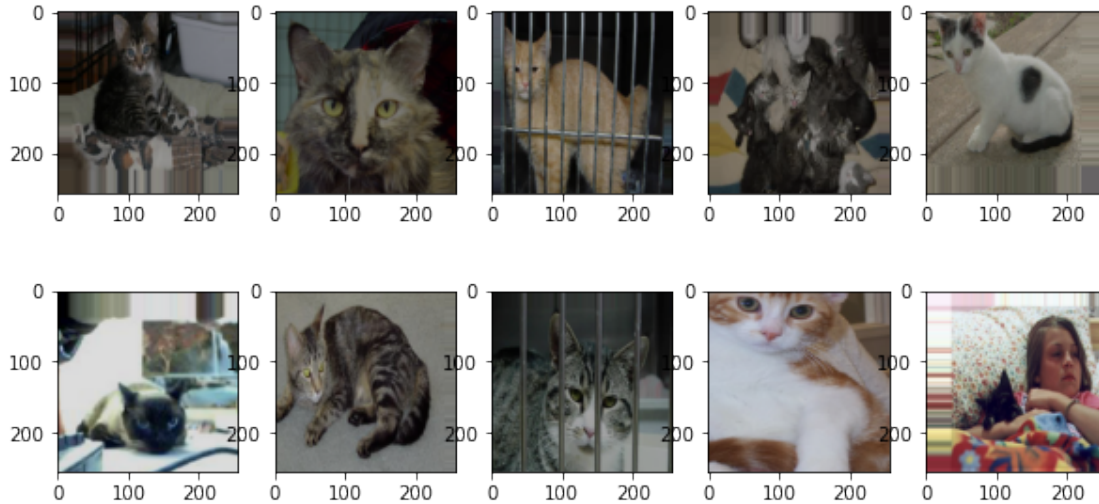
```

```

[28]: plt.figure(figsize=(10,5))
      show_generator_results(train_img_gen, 'cats', 10, 5, True)

```

Found 20 images belonging to 1 classes.

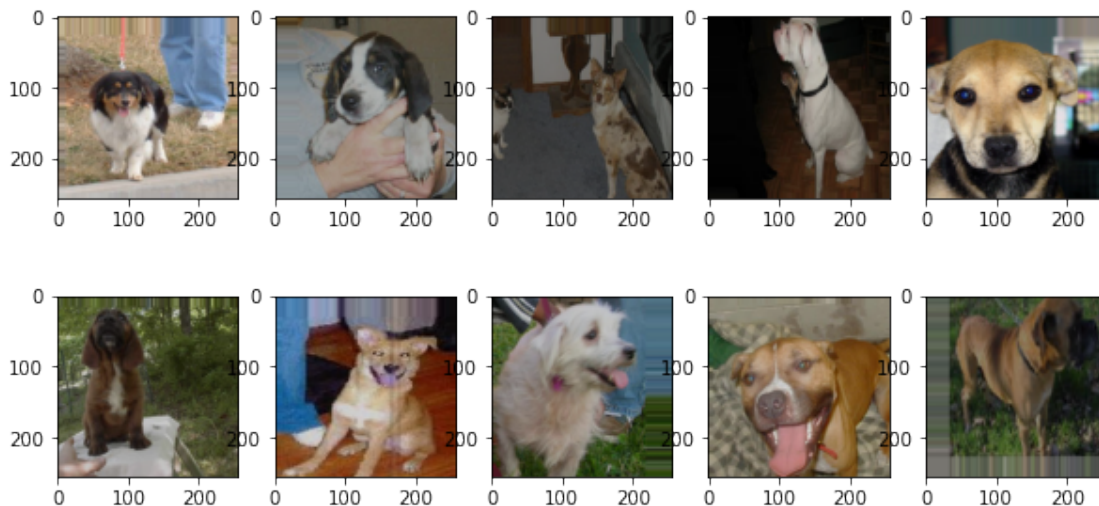


```

[29]: plt.figure(figsize=(10,5))
      show_generator_results(train_img_gen, 'dogs', 10, 5, True)

```

Found 20 images belonging to 1 classes.



```
[30]: train_data = train_img_gen.flow_from_directory('data/train',
                                                    target_size=(img_size,img_size),
                                                    classes=['cats', 'dogs'],
                                                    batch_size=batch_size,
                                                    seed=seed
                                                    )
```

Found 40 images belonging to 2 classes.

```
[31]: test_data = test_img_gen.flow_from_directory('data/test/',
                                                    target_size=(img_size,img_size),
                                                    batch_size=10,
                                                    classes=['cats', 'dogs'])
```

Found 20 images belonging to 2 classes.

## 1 Model Building

```
[32]: from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Dense, Dropout, Flatten
```

```
[33]: model = Sequential()

# Convolutional layer 1 with 32 filters of kernel size[5,5], input
# shape=128x128x3,
model.add(Conv2D(filters=32,
                  kernel_size=(5,5),
                  input_shape=(img_size, img_size, channels),
                  activation='relu'
                  ))

# Pooling layer 1 with pool size[2,2] and stride 2
model.add(MaxPooling2D(pool_size=(2,2),
                       strides=2
                       ))

# Convolutional layer 2 with 64 filters of kernel size[5,5]
model.add(Conv2D(filters=64,
                  kernel_size=(5,5),
                  activation='relu'
                  ))
```

```

# Pooling layer 2 with pool size[2,2] and stride 2
model.add(MaxPooling2D(pool_size=(2,2),
                        strides=2
                        ))

# Flatten Layer
model.add(Flatten())

# Dense layer 1 whose output size is fixed in the hyper parameter: fc_size=32
model.add(Dense(32, activation='relu'))

# Dropout Layer
model.add(Dropout(0.4))

# Output Layer
model.add(Dense(2, activation='softmax'))

```

```

[34]: model.compile(loss='categorical_crossentropy',
                    optimizer='adam',
                    metrics=['acc'],
                    )

```

```

[35]: model.summary()

```

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 220, 220, 32)	2432
max_pooling2d (MaxPooling2D)	(None, 110, 110, 32)	0
conv2d_1 (Conv2D)	(None, 106, 106, 64)	51264
max_pooling2d_1 (MaxPooling2D)	(None, 53, 53, 64)	0
flatten (Flatten)	(None, 179776)	0
dense (Dense)	(None, 32)	5752864
dropout (Dropout)	(None, 32)	0
dense_1 (Dense)	(None, 2)	66

Total params: 5,806,626  
 Trainable params: 5,806,626  
 Non-trainable params: 0



```
-----  
[36]: history = model.fit_generator(train_data,  
                                   epochs=100,  
                                   validation_data=test_data,  
                                   steps_per_epoch=train_data.n//batch_size,  
                                   validation_steps=test_data.n//10,  
                                   )
```

WARNING:tensorflow:From <ipython-input-36-a4db9ec13885>:5: Model.fit\_generator (from tensorflow.python.keras.engine.training) is deprecated and will be removed in a future version.

Instructions for updating:

Please use Model.fit, which supports generators.

Epoch 1/100

5/5 [=====] - 4s 855ms/step - loss: 4.2831 - acc: 0.5000 - val\_loss: 0.9719 - val\_acc: 0.5000

Epoch 2/100

5/5 [=====] - 4s 803ms/step - loss: 0.8024 - acc: 0.5000 - val\_loss: 0.7381 - val\_acc: 0.3500

Epoch 3/100

5/5 [=====] - 4s 798ms/step - loss: 0.7178 - acc: 0.4750 - val\_loss: 0.7178 - val\_acc: 0.5500

Epoch 4/100

5/5 [=====] - 4s 802ms/step - loss: 0.7391 - acc: 0.4750 - val\_loss: 0.6827 - val\_acc: 0.6000

Epoch 5/100

5/5 [=====] - 4s 800ms/step - loss: 0.6879 - acc: 0.4750 - val\_loss: 0.6850 - val\_acc: 0.6000

Epoch 6/100

5/5 [=====] - 4s 825ms/step - loss: 0.6884 - acc: 0.4500 - val\_loss: 0.6804 - val\_acc: 0.4500

Epoch 7/100

5/5 [=====] - 4s 802ms/step - loss: 0.6861 - acc: 0.5000 - val\_loss: 0.6783 - val\_acc: 0.5000

Epoch 8/100

5/5 [=====] - 4s 781ms/step - loss: 0.6822 - acc: 0.4750 - val\_loss: 0.6434 - val\_acc: 0.5000

Epoch 9/100

5/5 [=====] - 4s 778ms/step - loss: 0.6958 - acc: 0.5000 - val\_loss: 0.6723 - val\_acc: 0.5000

Epoch 10/100

5/5 [=====] - 4s 798ms/step - loss: 0.6793 - acc: 0.5000 - val\_loss: 0.6944 - val\_acc: 0.4500

Epoch 11/100

5/5 [=====] - 4s 797ms/step - loss: 0.6851 - acc: 0.5250 - val\_loss: 0.7736 - val\_acc: 0.5000

Epoch 12/100

5/5 [=====] - 4s 800ms/step - loss: 0.6989 - acc:  
0.5500 - val\_loss: 0.6619 - val\_acc: 0.6500  
Epoch 13/100  
5/5 [=====] - 4s 814ms/step - loss: 0.6606 - acc:  
0.6250 - val\_loss: 0.6724 - val\_acc: 0.5000  
Epoch 14/100  
5/5 [=====] - 4s 814ms/step - loss: 0.6855 - acc:  
0.4250 - val\_loss: 0.6721 - val\_acc: 0.4000  
Epoch 15/100  
5/5 [=====] - 4s 810ms/step - loss: 0.6883 - acc:  
0.5000 - val\_loss: 0.6629 - val\_acc: 0.5500  
Epoch 16/100  
5/5 [=====] - 4s 798ms/step - loss: 0.6750 - acc:  
0.5250 - val\_loss: 0.6628 - val\_acc: 0.6000  
Epoch 17/100  
5/5 [=====] - 4s 798ms/step - loss: 0.6688 - acc:  
0.4750 - val\_loss: 0.6594 - val\_acc: 0.6500  
Epoch 18/100  
5/5 [=====] - 4s 798ms/step - loss: 0.6710 - acc:  
0.5000 - val\_loss: 0.6719 - val\_acc: 0.4500  
Epoch 19/100  
5/5 [=====] - 4s 799ms/step - loss: 0.6822 - acc:  
0.5250 - val\_loss: 0.6747 - val\_acc: 0.5000  
Epoch 20/100  
5/5 [=====] - 4s 801ms/step - loss: 0.6756 - acc:  
0.5750 - val\_loss: 0.6951 - val\_acc: 0.4000  
Epoch 21/100  
5/5 [=====] - 4s 797ms/step - loss: 0.6801 - acc:  
0.5500 - val\_loss: 0.6712 - val\_acc: 0.5000  
Epoch 22/100  
5/5 [=====] - 4s 782ms/step - loss: 0.6702 - acc:  
0.5250 - val\_loss: 0.6374 - val\_acc: 0.5000  
Epoch 23/100  
5/5 [=====] - 4s 799ms/step - loss: 0.6701 - acc:  
0.5750 - val\_loss: 0.6638 - val\_acc: 0.5000  
Epoch 24/100  
5/5 [=====] - 4s 795ms/step - loss: 0.6677 - acc:  
0.5250 - val\_loss: 0.6483 - val\_acc: 0.5500  
Epoch 25/100  
5/5 [=====] - 4s 798ms/step - loss: 0.6764 - acc:  
0.5750 - val\_loss: 0.6711 - val\_acc: 0.5000  
Epoch 26/100  
5/5 [=====] - 4s 800ms/step - loss: 0.6646 - acc:  
0.5000 - val\_loss: 0.6917 - val\_acc: 0.7000  
Epoch 27/100  
5/5 [=====] - 4s 794ms/step - loss: 0.6675 - acc:  
0.4000 - val\_loss: 0.6642 - val\_acc: 0.7000  
Epoch 28/100

5/5 [=====] - 4s 797ms/step - loss: 0.6735 - acc:  
 0.4250 - val\_loss: 0.6306 - val\_acc: 0.6500  
 Epoch 29/100  
 5/5 [=====] - 4s 811ms/step - loss: 0.6601 - acc:  
 0.5250 - val\_loss: 0.6546 - val\_acc: 0.6000  
 Epoch 30/100  
 5/5 [=====] - 4s 797ms/step - loss: 0.6559 - acc:  
 0.6500 - val\_loss: 0.6505 - val\_acc: 0.7500  
 Epoch 31/100  
 5/5 [=====] - 4s 819ms/step - loss: 0.6769 - acc:  
 0.4750 - val\_loss: 0.6607 - val\_acc: 0.5500  
 Epoch 32/100  
 5/5 [=====] - 4s 800ms/step - loss: 0.6689 - acc:  
 0.5250 - val\_loss: 0.6826 - val\_acc: 0.5500  
 Epoch 33/100  
 5/5 [=====] - 4s 800ms/step - loss: 0.6630 - acc:  
 0.4750 - val\_loss: 0.6569 - val\_acc: 0.4000  
 Epoch 34/100  
 5/5 [=====] - 4s 795ms/step - loss: 0.6536 - acc:  
 0.4750 - val\_loss: 0.6894 - val\_acc: 0.4500  
 Epoch 35/100  
 5/5 [=====] - 4s 782ms/step - loss: 0.6662 - acc:  
 0.5250 - val\_loss: 0.6722 - val\_acc: 0.5500  
 Epoch 36/100  
 5/5 [=====] - 4s 797ms/step - loss: 0.6440 - acc:  
 0.5750 - val\_loss: 0.6177 - val\_acc: 0.7500  
 Epoch 37/100  
 5/5 [=====] - 4s 799ms/step - loss: 0.6374 - acc:  
 0.7000 - val\_loss: 0.6397 - val\_acc: 0.6500  
 Epoch 38/100  
 5/5 [=====] - 4s 801ms/step - loss: 0.6198 - acc:  
 0.5750 - val\_loss: 0.6893 - val\_acc: 0.5500  
 Epoch 39/100  
 5/5 [=====] - 4s 800ms/step - loss: 0.5760 - acc:  
 0.7750 - val\_loss: 0.6526 - val\_acc: 0.6000  
 Epoch 40/100  
 5/5 [=====] - 4s 799ms/step - loss: 0.7149 - acc:  
 0.6000 - val\_loss: 0.6216 - val\_acc: 0.6000  
 Epoch 41/100  
 5/5 [=====] - 4s 797ms/step - loss: 0.6398 - acc:  
 0.6500 - val\_loss: 0.6748 - val\_acc: 0.5500  
 Epoch 42/100  
 5/5 [=====] - 4s 796ms/step - loss: 0.6462 - acc:  
 0.6250 - val\_loss: 0.6875 - val\_acc: 0.4000  
 Epoch 43/100  
 5/5 [=====] - 4s 794ms/step - loss: 0.6506 - acc:  
 0.6000 - val\_loss: 0.6789 - val\_acc: 0.5000  
 Epoch 44/100

5/5 [=====] - 4s 798ms/step - loss: 0.6646 - acc:  
 0.5000 - val\_loss: 0.6660 - val\_acc: 0.6000  
 Epoch 45/100  
 5/5 [=====] - 4s 784ms/step - loss: 0.6558 - acc:  
 0.5750 - val\_loss: 0.6811 - val\_acc: 0.5000  
 Epoch 46/100  
 5/5 [=====] - 4s 800ms/step - loss: 0.6428 - acc:  
 0.6250 - val\_loss: 0.6830 - val\_acc: 0.5000  
 Epoch 47/100  
 5/5 [=====] - 4s 782ms/step - loss: 0.6579 - acc:  
 0.6750 - val\_loss: 0.6964 - val\_acc: 0.4500  
 Epoch 48/100  
 5/5 [=====] - 4s 799ms/step - loss: 0.6206 - acc:  
 0.6000 - val\_loss: 0.6997 - val\_acc: 0.4500  
 Epoch 49/100  
 5/5 [=====] - 4s 796ms/step - loss: 0.6309 - acc:  
 0.7250 - val\_loss: 0.7951 - val\_acc: 0.4500  
 Epoch 50/100  
 5/5 [=====] - 4s 796ms/step - loss: 0.6340 - acc:  
 0.6500 - val\_loss: 0.7459 - val\_acc: 0.4500  
 Epoch 51/100  
 5/5 [=====] - 4s 802ms/step - loss: 0.5592 - acc:  
 0.6750 - val\_loss: 1.1257 - val\_acc: 0.3500  
 Epoch 52/100  
 5/5 [=====] - 4s 800ms/step - loss: 0.7189 - acc:  
 0.6250 - val\_loss: 0.7579 - val\_acc: 0.4000  
 Epoch 53/100  
 5/5 [=====] - 4s 800ms/step - loss: 0.6282 - acc:  
 0.6250 - val\_loss: 0.6913 - val\_acc: 0.5000  
 Epoch 54/100  
 5/5 [=====] - 4s 797ms/step - loss: 0.6466 - acc:  
 0.5750 - val\_loss: 0.7099 - val\_acc: 0.4500  
 Epoch 55/100  
 5/5 [=====] - 4s 795ms/step - loss: 0.6343 - acc:  
 0.6000 - val\_loss: 0.6906 - val\_acc: 0.6500  
 Epoch 56/100  
 5/5 [=====] - 4s 788ms/step - loss: 0.6434 - acc:  
 0.5500 - val\_loss: 0.6895 - val\_acc: 0.5000  
 Epoch 57/100  
 5/5 [=====] - 4s 816ms/step - loss: 0.6261 - acc:  
 0.6500 - val\_loss: 0.6815 - val\_acc: 0.6500  
 Epoch 58/100  
 5/5 [=====] - 4s 785ms/step - loss: 0.6169 - acc:  
 0.5250 - val\_loss: 0.6702 - val\_acc: 0.7000  
 Epoch 59/100  
 5/5 [=====] - 4s 795ms/step - loss: 0.6279 - acc:  
 0.6000 - val\_loss: 0.6559 - val\_acc: 0.6500  
 Epoch 60/100

5/5 [=====] - 4s 798ms/step - loss: 0.6400 - acc:  
 0.5750 - val\_loss: 0.6521 - val\_acc: 0.6000  
 Epoch 61/100  
 5/5 [=====] - 4s 812ms/step - loss: 0.7202 - acc:  
 0.5500 - val\_loss: 0.6977 - val\_acc: 0.5000  
 Epoch 62/100  
 5/5 [=====] - 4s 799ms/step - loss: 0.6111 - acc:  
 0.7250 - val\_loss: 0.7100 - val\_acc: 0.4000  
 Epoch 63/100  
 5/5 [=====] - 4s 799ms/step - loss: 0.6402 - acc:  
 0.5500 - val\_loss: 0.6921 - val\_acc: 0.5000  
 Epoch 64/100  
 5/5 [=====] - 4s 800ms/step - loss: 0.6164 - acc:  
 0.6500 - val\_loss: 0.6613 - val\_acc: 0.4500  
 Epoch 65/100  
 5/5 [=====] - 4s 797ms/step - loss: 0.6429 - acc:  
 0.5750 - val\_loss: 0.6931 - val\_acc: 0.5500  
 Epoch 66/100  
 5/5 [=====] - 4s 798ms/step - loss: 0.6187 - acc:  
 0.6000 - val\_loss: 0.6775 - val\_acc: 0.6500  
 Epoch 67/100  
 5/5 [=====] - 4s 794ms/step - loss: 0.5528 - acc:  
 0.6250 - val\_loss: 0.7132 - val\_acc: 0.5000  
 Epoch 68/100  
 5/5 [=====] - 4s 796ms/step - loss: 0.5539 - acc:  
 0.6750 - val\_loss: 0.7623 - val\_acc: 0.4500  
 Epoch 69/100  
 5/5 [=====] - 4s 794ms/step - loss: 0.6097 - acc:  
 0.5000 - val\_loss: 0.7483 - val\_acc: 0.6000  
 Epoch 70/100  
 5/5 [=====] - 4s 798ms/step - loss: 0.5011 - acc:  
 0.7250 - val\_loss: 0.8219 - val\_acc: 0.3500  
 Epoch 71/100  
 5/5 [=====] - 4s 798ms/step - loss: 0.5708 - acc:  
 0.7250 - val\_loss: 0.7411 - val\_acc: 0.4500  
 Epoch 72/100  
 5/5 [=====] - 4s 798ms/step - loss: 0.5271 - acc:  
 0.7000 - val\_loss: 0.7938 - val\_acc: 0.3000  
 Epoch 73/100  
 5/5 [=====] - 4s 797ms/step - loss: 0.5563 - acc:  
 0.6500 - val\_loss: 0.6919 - val\_acc: 0.4000  
 Epoch 74/100  
 5/5 [=====] - 4s 783ms/step - loss: 0.5602 - acc:  
 0.6750 - val\_loss: 0.6523 - val\_acc: 0.4500  
 Epoch 75/100  
 5/5 [=====] - 4s 797ms/step - loss: 0.4693 - acc:  
 0.7750 - val\_loss: 0.9853 - val\_acc: 0.5500  
 Epoch 76/100

5/5 [=====] - 4s 795ms/step - loss: 0.5846 - acc:  
0.7250 - val\_loss: 1.1718 - val\_acc: 0.5500  
Epoch 77/100  
5/5 [=====] - 4s 812ms/step - loss: 0.5735 - acc:  
0.6000 - val\_loss: 1.3045 - val\_acc: 0.4500  
Epoch 78/100  
5/5 [=====] - 4s 797ms/step - loss: 0.4446 - acc:  
0.7750 - val\_loss: 0.7875 - val\_acc: 0.4000  
Epoch 79/100  
5/5 [=====] - 4s 801ms/step - loss: 0.4535 - acc:  
0.7500 - val\_loss: 1.4040 - val\_acc: 0.4500  
Epoch 80/100  
5/5 [=====] - 4s 800ms/step - loss: 0.4542 - acc:  
0.7500 - val\_loss: 1.4733 - val\_acc: 0.6000  
Epoch 81/100  
5/5 [=====] - 4s 801ms/step - loss: 0.4742 - acc:  
0.7000 - val\_loss: 1.5866 - val\_acc: 0.3000  
Epoch 82/100  
5/5 [=====] - 4s 813ms/step - loss: 0.4858 - acc:  
0.7750 - val\_loss: 1.0990 - val\_acc: 0.3500  
Epoch 83/100  
5/5 [=====] - 4s 814ms/step - loss: 0.6456 - acc:  
0.6250 - val\_loss: 0.6849 - val\_acc: 0.5000  
Epoch 84/100  
5/5 [=====] - 4s 798ms/step - loss: 0.5637 - acc:  
0.6750 - val\_loss: 0.6912 - val\_acc: 0.4500  
Epoch 85/100  
5/5 [=====] - 4s 800ms/step - loss: 0.5873 - acc:  
0.6750 - val\_loss: 0.6733 - val\_acc: 0.5000  
Epoch 86/100  
5/5 [=====] - 4s 798ms/step - loss: 0.5931 - acc:  
0.6250 - val\_loss: 0.6331 - val\_acc: 0.6500  
Epoch 87/100  
5/5 [=====] - 4s 801ms/step - loss: 0.5932 - acc:  
0.6500 - val\_loss: 0.6518 - val\_acc: 0.5000  
Epoch 88/100  
5/5 [=====] - 4s 797ms/step - loss: 0.5800 - acc:  
0.6000 - val\_loss: 0.7031 - val\_acc: 0.4000  
Epoch 89/100  
5/5 [=====] - 4s 803ms/step - loss: 0.5500 - acc:  
0.5750 - val\_loss: 0.7137 - val\_acc: 0.3000  
Epoch 90/100  
5/5 [=====] - 4s 800ms/step - loss: 0.5991 - acc:  
0.5750 - val\_loss: 0.6749 - val\_acc: 0.2500  
Epoch 91/100  
5/5 [=====] - 4s 797ms/step - loss: 0.5569 - acc:  
0.7000 - val\_loss: 0.6694 - val\_acc: 0.3000  
Epoch 92/100



```

5/5 [=====] - 4s 803ms/step - loss: 0.6065 - acc:
0.5500 - val_loss: 0.7917 - val_acc: 0.3500
Epoch 93/100
5/5 [=====] - 4s 837ms/step - loss: 0.5612 - acc:
0.7000 - val_loss: 0.8075 - val_acc: 0.3500
Epoch 94/100
5/5 [=====] - 4s 801ms/step - loss: 0.5818 - acc:
0.6000 - val_loss: 0.7062 - val_acc: 0.4000
Epoch 95/100
5/5 [=====] - 4s 803ms/step - loss: 0.6163 - acc:
0.6250 - val_loss: 0.7074 - val_acc: 0.4000
Epoch 96/100
5/5 [=====] - 4s 797ms/step - loss: 0.6221 - acc:
0.6500 - val_loss: 0.7651 - val_acc: 0.3500
Epoch 97/100
5/5 [=====] - 4s 813ms/step - loss: 0.6251 - acc:
0.7000 - val_loss: 0.8354 - val_acc: 0.4000
Epoch 98/100
5/5 [=====] - 4s 817ms/step - loss: 0.5738 - acc:
0.6500 - val_loss: 0.7846 - val_acc: 0.3000
Epoch 99/100
5/5 [=====] - 4s 814ms/step - loss: 0.6406 - acc:
0.6500 - val_loss: 0.7560 - val_acc: 0.2500
Epoch 100/100
5/5 [=====] - 4s 803ms/step - loss: 0.5577 - acc:
0.6500 - val_loss: 0.8134 - val_acc: 0.2500

```

## 2 Evaluation

```

[37]: acc = history.history['acc']
      val_acc = history.history['val_acc']

      loss = history.history['loss']
      val_loss = history.history['val_loss']

      epochs = range(len(acc))

```

```

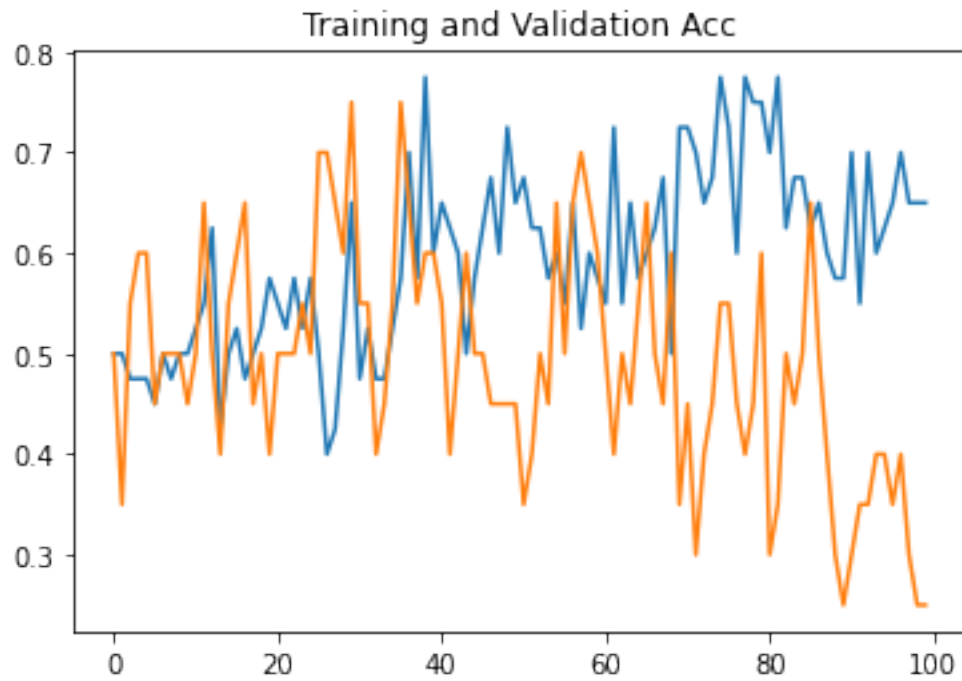
[38]: plt.plot(epochs, acc)
      plt.plot(epochs, val_acc)
      plt.title('Training and Validation Acc')

```

```

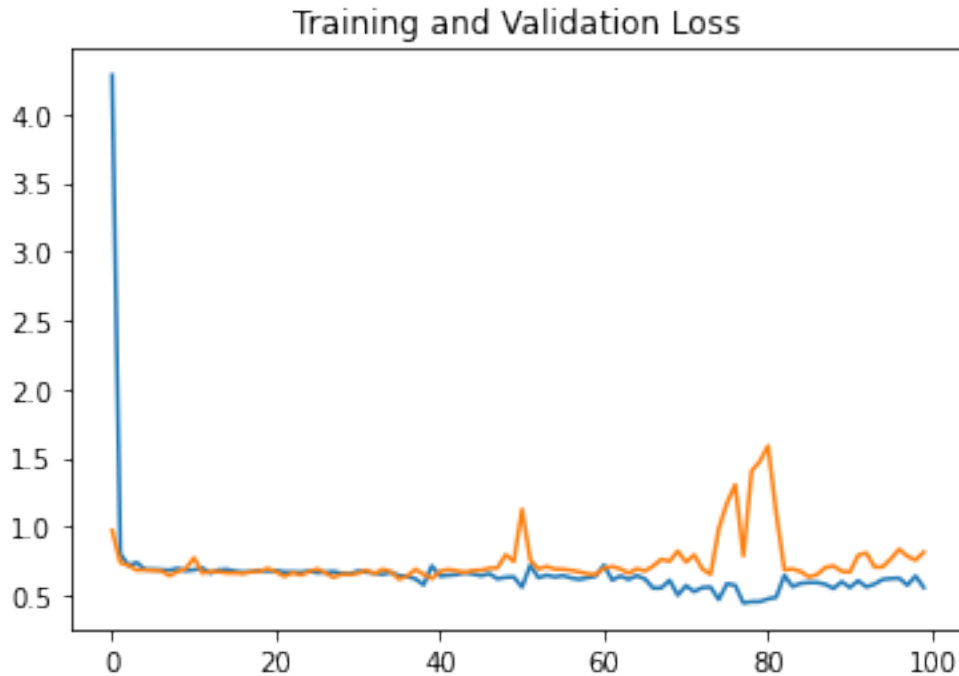
[38]: Text(0.5, 1.0, 'Training and Validation Acc')

```



```
[39]: plt.plot(epochs, loss)
      plt.plot(epochs, val_loss)
      plt.title('Training and Validation Loss')
```

```
[39]: Text(0.5, 1.0, 'Training and Validation Loss')
```



```
[40]: _, acc = model.evaluate_generator(test_data, steps=test_data.n, verbose=0)
      print('> %.3f' % (acc * 100.0))
```

WARNING:tensorflow:From <ipython-input-40-ab90825a0fac>:1:  
 Model.evaluate\_generator (from tensorflow.python.keras.engine.training) is  
 deprecated and will be removed in a future version.  
 Instructions for updating:  
 Please use Model.evaluate, which supports generators.  
 > 40.000

```
[42]: history = model.fit_generator(train_data,
                                   epochs=200,
                                   validation_data=test_data,
                                   steps_per_epoch=train_data.n//batch_size,
                                   validation_steps=test_data.n//10,
                                   )
```

```
Epoch 1/200
5/5 [=====] - 4s 786ms/step - loss: 0.5436 - acc:
0.7000 - val_loss: 0.8035 - val_acc: 0.2500
Epoch 2/200
5/5 [=====] - 4s 792ms/step - loss: 0.5300 - acc:
0.6500 - val_loss: 0.7853 - val_acc: 0.4000
Epoch 3/200
5/5 [=====] - 4s 795ms/step - loss: 0.5177 - acc:
```

```

0.7250 - val_loss: 0.8421 - val_acc: 0.4000
Epoch 4/200
5/5 [=====] - 4s 798ms/step - loss: 0.4983 - acc:
0.7000 - val_loss: 0.8133 - val_acc: 0.4000
Epoch 5/200
5/5 [=====] - 4s 797ms/step - loss: 0.4447 - acc:
0.7500 - val_loss: 0.7752 - val_acc: 0.4500
Epoch 6/200
5/5 [=====] - 4s 800ms/step - loss: 0.6241 - acc:
0.6500 - val_loss: 0.8204 - val_acc: 0.4000
Epoch 7/200
5/5 [=====] - 4s 800ms/step - loss: 0.4955 - acc:
0.7000 - val_loss: 0.9596 - val_acc: 0.3500
Epoch 8/200
5/5 [=====] - 4s 811ms/step - loss: 0.6336 - acc:
0.6750 - val_loss: 0.7998 - val_acc: 0.3500
Epoch 9/200
5/5 [=====] - 4s 814ms/step - loss: 0.5024 - acc:
0.7750 - val_loss: 0.7820 - val_acc: 0.3500
Epoch 10/200
5/5 [=====] - 4s 804ms/step - loss: 0.5564 - acc:
0.6500 - val_loss: 0.7069 - val_acc: 0.5000
Epoch 11/200
5/5 [=====] - 4s 799ms/step - loss: 0.5614 - acc:
0.6250 - val_loss: 0.7288 - val_acc: 0.3500
Epoch 12/200
5/5 [=====] - 4s 801ms/step - loss: 0.4877 - acc:
0.7250 - val_loss: 0.7004 - val_acc: 0.5000
Epoch 13/200
5/5 [=====] - 4s 799ms/step - loss: 0.5219 - acc:
0.6750 - val_loss: 0.7136 - val_acc: 0.5000
Epoch 14/200
5/5 [=====] - 4s 795ms/step - loss: 0.4897 - acc:
0.7000 - val_loss: 0.7281 - val_acc: 0.4000
Epoch 15/200
5/5 [=====] - 4s 784ms/step - loss: 0.6198 - acc:
0.6000 - val_loss: 0.7490 - val_acc: 0.4500
Epoch 16/200
5/5 [=====] - 4s 798ms/step - loss: 0.4886 - acc:
0.7250 - val_loss: 0.7491 - val_acc: 0.4500
Epoch 17/200
5/5 [=====] - 4s 794ms/step - loss: 0.5593 - acc:
0.6500 - val_loss: 0.8545 - val_acc: 0.2000
Epoch 18/200
5/5 [=====] - 4s 796ms/step - loss: 0.4754 - acc:
0.6750 - val_loss: 0.7483 - val_acc: 0.5000
Epoch 19/200
5/5 [=====] - 4s 795ms/step - loss: 0.4807 - acc:

```

0.6500 - val\_loss: 0.7061 - val\_acc: 0.5500  
 Epoch 20/200  
 5/5 [=====] - 4s 783ms/step - loss: 0.5791 - acc:  
 0.7500 - val\_loss: 0.7201 - val\_acc: 0.5500  
 Epoch 21/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.4865 - acc:  
 0.7500 - val\_loss: 0.6943 - val\_acc: 0.5000  
 Epoch 22/200  
 5/5 [=====] - 4s 794ms/step - loss: 0.5605 - acc:  
 0.6000 - val\_loss: 0.6882 - val\_acc: 0.5000  
 Epoch 23/200  
 5/5 [=====] - 4s 797ms/step - loss: 0.4947 - acc:  
 0.7250 - val\_loss: 0.5872 - val\_acc: 0.6000  
 Epoch 24/200  
 5/5 [=====] - 4s 780ms/step - loss: 0.4235 - acc:  
 0.7000 - val\_loss: 0.6962 - val\_acc: 0.5500  
 Epoch 25/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.5026 - acc:  
 0.7500 - val\_loss: 0.6181 - val\_acc: 0.6000  
 Epoch 26/200  
 5/5 [=====] - 4s 793ms/step - loss: 0.4575 - acc:  
 0.7250 - val\_loss: 0.7073 - val\_acc: 0.5500  
 Epoch 27/200  
 5/5 [=====] - 4s 779ms/step - loss: 0.4926 - acc:  
 0.7250 - val\_loss: 0.7302 - val\_acc: 0.5500  
 Epoch 28/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.4447 - acc:  
 0.8000 - val\_loss: 0.7245 - val\_acc: 0.5000  
 Epoch 29/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.5411 - acc:  
 0.7250 - val\_loss: 0.7183 - val\_acc: 0.5000  
 Epoch 30/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.5527 - acc:  
 0.7500 - val\_loss: 0.8538 - val\_acc: 0.4500  
 Epoch 31/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.4317 - acc:  
 0.7500 - val\_loss: 1.8457 - val\_acc: 0.4500  
 Epoch 32/200  
 5/5 [=====] - 4s 792ms/step - loss: 0.6359 - acc:  
 0.7000 - val\_loss: 0.8707 - val\_acc: 0.5000  
 Epoch 33/200  
 5/5 [=====] - 4s 795ms/step - loss: 0.4433 - acc:  
 0.8250 - val\_loss: 0.9783 - val\_acc: 0.4000  
 Epoch 34/200  
 5/5 [=====] - 4s 791ms/step - loss: 0.4682 - acc:  
 0.7250 - val\_loss: 0.8033 - val\_acc: 0.4500  
 Epoch 35/200  
 5/5 [=====] - 4s 796ms/step - loss: 0.5797 - acc:

0.6250 - val\_loss: 0.7992 - val\_acc: 0.5500  
 Epoch 36/200  
 5/5 [=====] - 4s 795ms/step - loss: 0.4509 - acc:  
 0.7500 - val\_loss: 0.8219 - val\_acc: 0.5000  
 Epoch 37/200  
 5/5 [=====] - 4s 776ms/step - loss: 0.4637 - acc:  
 0.7500 - val\_loss: 0.8362 - val\_acc: 0.4500  
 Epoch 38/200  
 5/5 [=====] - 4s 778ms/step - loss: 0.6235 - acc:  
 0.6000 - val\_loss: 0.7486 - val\_acc: 0.5000  
 Epoch 39/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.4999 - acc:  
 0.7000 - val\_loss: 0.7486 - val\_acc: 0.4000  
 Epoch 40/200  
 5/5 [=====] - 4s 796ms/step - loss: 0.6015 - acc:  
 0.6750 - val\_loss: 0.7238 - val\_acc: 0.4500  
 Epoch 41/200  
 5/5 [=====] - 4s 796ms/step - loss: 0.4156 - acc:  
 0.7750 - val\_loss: 0.8694 - val\_acc: 0.4000  
 Epoch 42/200  
 5/5 [=====] - 4s 799ms/step - loss: 0.5019 - acc:  
 0.7750 - val\_loss: 0.7320 - val\_acc: 0.5000  
 Epoch 43/200  
 5/5 [=====] - 4s 796ms/step - loss: 0.4325 - acc:  
 0.8000 - val\_loss: 0.6974 - val\_acc: 0.6000  
 Epoch 44/200  
 5/5 [=====] - 4s 793ms/step - loss: 0.4911 - acc:  
 0.8000 - val\_loss: 0.7465 - val\_acc: 0.5000  
 Epoch 45/200  
 5/5 [=====] - 4s 798ms/step - loss: 0.4761 - acc:  
 0.7000 - val\_loss: 0.7384 - val\_acc: 0.3000  
 Epoch 46/200  
 5/5 [=====] - 4s 796ms/step - loss: 0.4924 - acc:  
 0.7000 - val\_loss: 0.7433 - val\_acc: 0.4000  
 Epoch 47/200  
 5/5 [=====] - 4s 815ms/step - loss: 0.4634 - acc:  
 0.7250 - val\_loss: 0.7552 - val\_acc: 0.3000  
 Epoch 48/200  
 5/5 [=====] - 4s 795ms/step - loss: 0.5079 - acc:  
 0.7250 - val\_loss: 0.7646 - val\_acc: 0.4000  
 Epoch 49/200  
 5/5 [=====] - 4s 795ms/step - loss: 0.4493 - acc:  
 0.7500 - val\_loss: 0.8040 - val\_acc: 0.5500  
 Epoch 50/200  
 5/5 [=====] - 4s 793ms/step - loss: 0.4924 - acc:  
 0.8250 - val\_loss: 0.7817 - val\_acc: 0.5500  
 Epoch 51/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.4705 - acc:



0.7250 - val\_loss: 0.5746 - val\_acc: 0.7000  
 Epoch 52/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.4009 - acc:  
 0.8500 - val\_loss: 0.8122 - val\_acc: 0.5500  
 Epoch 53/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.4989 - acc:  
 0.7000 - val\_loss: 0.7997 - val\_acc: 0.6000  
 Epoch 54/200  
 5/5 [=====] - 4s 783ms/step - loss: 0.4672 - acc:  
 0.8000 - val\_loss: 0.8541 - val\_acc: 0.5500  
 Epoch 55/200  
 5/5 [=====] - 4s 799ms/step - loss: 0.4853 - acc:  
 0.8000 - val\_loss: 0.6303 - val\_acc: 0.6000  
 Epoch 56/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.4705 - acc:  
 0.7750 - val\_loss: 0.7176 - val\_acc: 0.5500  
 Epoch 57/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.5180 - acc:  
 0.7000 - val\_loss: 0.7337 - val\_acc: 0.5000  
 Epoch 58/200  
 5/5 [=====] - 4s 798ms/step - loss: 0.4612 - acc:  
 0.7250 - val\_loss: 0.6842 - val\_acc: 0.5000  
 Epoch 59/200  
 5/5 [=====] - 4s 796ms/step - loss: 0.4329 - acc:  
 0.7750 - val\_loss: 0.8256 - val\_acc: 0.3000  
 Epoch 60/200  
 5/5 [=====] - 4s 800ms/step - loss: 0.5325 - acc:  
 0.6000 - val\_loss: 0.7209 - val\_acc: 0.4000  
 Epoch 61/200  
 5/5 [=====] - 4s 816ms/step - loss: 0.4440 - acc:  
 0.8250 - val\_loss: 0.7133 - val\_acc: 0.4500  
 Epoch 62/200  
 5/5 [=====] - 4s 783ms/step - loss: 0.3440 - acc:  
 0.8500 - val\_loss: 2.0239 - val\_acc: 0.5500  
 Epoch 63/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.9277 - acc:  
 0.6500 - val\_loss: 0.7229 - val\_acc: 0.5500  
 Epoch 64/200  
 5/5 [=====] - 4s 797ms/step - loss: 0.4915 - acc:  
 0.8000 - val\_loss: 0.7091 - val\_acc: 0.5000  
 Epoch 65/200  
 5/5 [=====] - 4s 784ms/step - loss: 0.4916 - acc:  
 0.7250 - val\_loss: 0.7403 - val\_acc: 0.5000  
 Epoch 66/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.5009 - acc:  
 0.6750 - val\_loss: 0.7318 - val\_acc: 0.5500  
 Epoch 67/200  
 5/5 [=====] - 4s 784ms/step - loss: 0.4788 - acc:

0.7000 - val\_loss: 0.6682 - val\_acc: 0.6000  
 Epoch 68/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.4261 - acc:  
 0.8250 - val\_loss: 0.7170 - val\_acc: 0.5500  
 Epoch 69/200  
 5/5 [=====] - 4s 780ms/step - loss: 0.4301 - acc:  
 0.8000 - val\_loss: 0.5764 - val\_acc: 0.4500  
 Epoch 70/200  
 5/5 [=====] - 4s 784ms/step - loss: 0.5208 - acc:  
 0.7250 - val\_loss: 0.6819 - val\_acc: 0.6000  
 Epoch 71/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.3648 - acc:  
 0.8500 - val\_loss: 0.6902 - val\_acc: 0.5000  
 Epoch 72/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.4552 - acc:  
 0.6500 - val\_loss: 0.7576 - val\_acc: 0.4000  
 Epoch 73/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.5026 - acc:  
 0.7250 - val\_loss: 0.7710 - val\_acc: 0.3500  
 Epoch 74/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.4847 - acc:  
 0.7000 - val\_loss: 0.7173 - val\_acc: 0.4000  
 Epoch 75/200  
 5/5 [=====] - 4s 783ms/step - loss: 0.4762 - acc:  
 0.7500 - val\_loss: 0.5596 - val\_acc: 0.6000  
 Epoch 76/200  
 5/5 [=====] - 4s 780ms/step - loss: 0.3923 - acc:  
 0.8000 - val\_loss: 0.6458 - val\_acc: 0.6000  
 Epoch 77/200  
 5/5 [=====] - 4s 793ms/step - loss: 0.6041 - acc:  
 0.7500 - val\_loss: 0.7295 - val\_acc: 0.4500  
 Epoch 78/200  
 5/5 [=====] - 4s 792ms/step - loss: 0.4095 - acc:  
 0.7500 - val\_loss: 0.8382 - val\_acc: 0.5000  
 Epoch 79/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.4981 - acc:  
 0.6750 - val\_loss: 0.8556 - val\_acc: 0.3500  
 Epoch 80/200  
 5/5 [=====] - 4s 778ms/step - loss: 0.4768 - acc:  
 0.7750 - val\_loss: 0.8985 - val\_acc: 0.4000  
 Epoch 81/200  
 5/5 [=====] - 4s 776ms/step - loss: 0.4275 - acc:  
 0.7250 - val\_loss: 0.6454 - val\_acc: 0.4000  
 Epoch 82/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.4141 - acc:  
 0.7750 - val\_loss: 0.8273 - val\_acc: 0.5500  
 Epoch 83/200  
 5/5 [=====] - 4s 783ms/step - loss: 0.4320 - acc:

0.7500 - val\_loss: 0.7236 - val\_acc: 0.4500  
 Epoch 84/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.4017 - acc:  
 0.7750 - val\_loss: 0.9506 - val\_acc: 0.5500  
 Epoch 85/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.4300 - acc:  
 0.8000 - val\_loss: 1.0201 - val\_acc: 0.5000  
 Epoch 86/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.3999 - acc:  
 0.8000 - val\_loss: 1.1195 - val\_acc: 0.5000  
 Epoch 87/200  
 5/5 [=====] - 4s 813ms/step - loss: 0.3561 - acc:  
 0.8750 - val\_loss: 1.1023 - val\_acc: 0.6000  
 Epoch 88/200  
 5/5 [=====] - 4s 796ms/step - loss: 0.4641 - acc:  
 0.7000 - val\_loss: 1.1892 - val\_acc: 0.5000  
 Epoch 89/200  
 5/5 [=====] - 4s 783ms/step - loss: 0.3869 - acc:  
 0.7750 - val\_loss: 1.4580 - val\_acc: 0.4500  
 Epoch 90/200  
 5/5 [=====] - 4s 785ms/step - loss: 0.4645 - acc:  
 0.7750 - val\_loss: 1.0737 - val\_acc: 0.5000  
 Epoch 91/200  
 5/5 [=====] - 4s 783ms/step - loss: 0.5542 - acc:  
 0.7750 - val\_loss: 1.1034 - val\_acc: 0.3500  
 Epoch 92/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.4143 - acc:  
 0.7250 - val\_loss: 1.0490 - val\_acc: 0.5500  
 Epoch 93/200  
 5/5 [=====] - 4s 838ms/step - loss: 0.4949 - acc:  
 0.8000 - val\_loss: 1.0931 - val\_acc: 0.5000  
 Epoch 94/200  
 5/5 [=====] - 4s 794ms/step - loss: 0.4188 - acc:  
 0.7000 - val\_loss: 0.8872 - val\_acc: 0.5500  
 Epoch 95/200  
 5/5 [=====] - 4s 797ms/step - loss: 0.4144 - acc:  
 0.6750 - val\_loss: 0.6828 - val\_acc: 0.5000  
 Epoch 96/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.4757 - acc:  
 0.7500 - val\_loss: 0.9171 - val\_acc: 0.5500  
 Epoch 97/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.3820 - acc:  
 0.7750 - val\_loss: 0.6574 - val\_acc: 0.5500  
 Epoch 98/200  
 5/5 [=====] - 4s 794ms/step - loss: 0.5293 - acc:  
 0.7000 - val\_loss: 1.0063 - val\_acc: 0.5500  
 Epoch 99/200  
 5/5 [=====] - 4s 795ms/step - loss: 0.4042 - acc:

0.8250 - val\_loss: 0.8545 - val\_acc: 0.6000  
 Epoch 100/200  
 5/5 [=====] - 4s 795ms/step - loss: 0.4516 - acc:  
 0.8500 - val\_loss: 1.2915 - val\_acc: 0.5000  
 Epoch 101/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.3996 - acc:  
 0.8000 - val\_loss: 1.5779 - val\_acc: 0.4000  
 Epoch 102/200  
 5/5 [=====] - 4s 798ms/step - loss: 0.4007 - acc:  
 0.7250 - val\_loss: 1.6225 - val\_acc: 0.4500  
 Epoch 103/200  
 5/5 [=====] - 4s 793ms/step - loss: 0.2323 - acc:  
 0.9250 - val\_loss: 3.1046 - val\_acc: 0.4000  
 Epoch 104/200  
 5/5 [=====] - 4s 794ms/step - loss: 0.6202 - acc:  
 0.7750 - val\_loss: 1.8022 - val\_acc: 0.5500  
 Epoch 105/200  
 5/5 [=====] - 4s 794ms/step - loss: 0.7159 - acc:  
 0.7250 - val\_loss: 0.7711 - val\_acc: 0.4000  
 Epoch 106/200  
 5/5 [=====] - 4s 784ms/step - loss: 0.4736 - acc:  
 0.8000 - val\_loss: 0.8220 - val\_acc: 0.4500  
 Epoch 107/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.4994 - acc:  
 0.7000 - val\_loss: 0.8740 - val\_acc: 0.2500  
 Epoch 108/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.5584 - acc:  
 0.7500 - val\_loss: 0.8867 - val\_acc: 0.3500  
 Epoch 109/200  
 5/5 [=====] - 4s 796ms/step - loss: 0.4688 - acc:  
 0.8500 - val\_loss: 1.2954 - val\_acc: 0.3500  
 Epoch 110/200  
 5/5 [=====] - 4s 793ms/step - loss: 1.0929 - acc:  
 0.6500 - val\_loss: 1.0064 - val\_acc: 0.3000  
 Epoch 111/200  
 5/5 [=====] - 4s 797ms/step - loss: 0.5365 - acc:  
 0.6750 - val\_loss: 0.8028 - val\_acc: 0.4500  
 Epoch 112/200  
 5/5 [=====] - 4s 784ms/step - loss: 0.4678 - acc:  
 0.7750 - val\_loss: 0.7769 - val\_acc: 0.3500  
 Epoch 113/200  
 5/5 [=====] - 4s 795ms/step - loss: 0.5439 - acc:  
 0.7500 - val\_loss: 0.7797 - val\_acc: 0.4500  
 Epoch 114/200  
 5/5 [=====] - 4s 793ms/step - loss: 1.8729 - acc:  
 0.6250 - val\_loss: 0.7736 - val\_acc: 0.4500  
 Epoch 115/200  
 5/5 [=====] - 4s 795ms/step - loss: 0.4101 - acc:

0.8250 - val\_loss: 0.7391 - val\_acc: 0.4500  
 Epoch 116/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.4728 - acc:  
 0.7750 - val\_loss: 0.7282 - val\_acc: 0.6500  
 Epoch 117/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.5443 - acc:  
 0.7500 - val\_loss: 0.9232 - val\_acc: 0.4000  
 Epoch 118/200  
 5/5 [=====] - 4s 798ms/step - loss: 0.4185 - acc:  
 0.7250 - val\_loss: 0.8443 - val\_acc: 0.4000  
 Epoch 119/200  
 5/5 [=====] - 4s 798ms/step - loss: 0.5739 - acc:  
 0.7250 - val\_loss: 0.7288 - val\_acc: 0.4500  
 Epoch 120/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.4705 - acc:  
 0.8000 - val\_loss: 0.7940 - val\_acc: 0.4500  
 Epoch 121/200  
 5/5 [=====] - 4s 776ms/step - loss: 0.5540 - acc:  
 0.7000 - val\_loss: 0.5614 - val\_acc: 0.6000  
 Epoch 122/200  
 5/5 [=====] - 4s 798ms/step - loss: 0.4708 - acc:  
 0.7500 - val\_loss: 0.7604 - val\_acc: 0.5500  
 Epoch 123/200  
 5/5 [=====] - 4s 779ms/step - loss: 0.3131 - acc:  
 0.8250 - val\_loss: 0.8754 - val\_acc: 0.6000  
 Epoch 124/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.6747 - acc:  
 0.7500 - val\_loss: 0.7858 - val\_acc: 0.5000  
 Epoch 125/200  
 5/5 [=====] - 4s 794ms/step - loss: 0.4927 - acc:  
 0.7500 - val\_loss: 0.6490 - val\_acc: 0.4000  
 Epoch 126/200  
 5/5 [=====] - 4s 795ms/step - loss: 0.5545 - acc:  
 0.6250 - val\_loss: 0.7571 - val\_acc: 0.4000  
 Epoch 127/200  
 5/5 [=====] - 4s 796ms/step - loss: 0.4399 - acc:  
 0.8250 - val\_loss: 0.6295 - val\_acc: 0.5000  
 Epoch 128/200  
 5/5 [=====] - 4s 792ms/step - loss: 0.5750 - acc:  
 0.6000 - val\_loss: 0.7697 - val\_acc: 0.3500  
 Epoch 129/200  
 5/5 [=====] - 4s 793ms/step - loss: 0.6644 - acc:  
 0.6750 - val\_loss: 0.9323 - val\_acc: 0.4000  
 Epoch 130/200  
 5/5 [=====] - 4s 791ms/step - loss: 0.4366 - acc:  
 0.7500 - val\_loss: 0.8746 - val\_acc: 0.5000  
 Epoch 131/200  
 5/5 [=====] - 4s 778ms/step - loss: 0.4478 - acc:

0.7000 - val\_loss: 1.0556 - val\_acc: 0.2500  
 Epoch 132/200  
 5/5 [=====] - 4s 795ms/step - loss: 0.4713 - acc:  
 0.8250 - val\_loss: 0.8448 - val\_acc: 0.5500  
 Epoch 133/200  
 5/5 [=====] - 4s 790ms/step - loss: 0.4297 - acc:  
 0.7250 - val\_loss: 0.6159 - val\_acc: 0.4500  
 Epoch 134/200  
 5/5 [=====] - 4s 797ms/step - loss: 0.4560 - acc:  
 0.7500 - val\_loss: 0.8527 - val\_acc: 0.5500  
 Epoch 135/200  
 5/5 [=====] - 4s 792ms/step - loss: 0.4854 - acc:  
 0.8500 - val\_loss: 0.9135 - val\_acc: 0.5000  
 Epoch 136/200  
 5/5 [=====] - 4s 792ms/step - loss: 0.4483 - acc:  
 0.7500 - val\_loss: 0.9652 - val\_acc: 0.4500  
 Epoch 137/200  
 5/5 [=====] - 4s 794ms/step - loss: 0.4674 - acc:  
 0.7250 - val\_loss: 1.0029 - val\_acc: 0.4000  
 Epoch 138/200  
 5/5 [=====] - 4s 793ms/step - loss: 0.3505 - acc:  
 0.8750 - val\_loss: 0.9504 - val\_acc: 0.5500  
 Epoch 139/200  
 5/5 [=====] - 4s 814ms/step - loss: 0.3786 - acc:  
 0.8000 - val\_loss: 0.7307 - val\_acc: 0.4000  
 Epoch 140/200  
 5/5 [=====] - 4s 794ms/step - loss: 0.3929 - acc:  
 0.7750 - val\_loss: 0.9131 - val\_acc: 0.5500  
 Epoch 141/200  
 5/5 [=====] - 4s 784ms/step - loss: 0.2906 - acc:  
 0.9000 - val\_loss: 1.0177 - val\_acc: 0.5000  
 Epoch 142/200  
 5/5 [=====] - 4s 796ms/step - loss: 0.4872 - acc:  
 0.7000 - val\_loss: 1.0153 - val\_acc: 0.5500  
 Epoch 143/200  
 5/5 [=====] - 4s 796ms/step - loss: 0.4216 - acc:  
 0.8250 - val\_loss: 0.8486 - val\_acc: 0.3000  
 Epoch 144/200  
 5/5 [=====] - 4s 791ms/step - loss: 0.4037 - acc:  
 0.7750 - val\_loss: 1.2130 - val\_acc: 0.4000  
 Epoch 145/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.3574 - acc:  
 0.8000 - val\_loss: 1.6819 - val\_acc: 0.3000  
 Epoch 146/200  
 5/5 [=====] - 4s 780ms/step - loss: 0.3544 - acc:  
 0.8500 - val\_loss: 1.4988 - val\_acc: 0.3500  
 Epoch 147/200  
 5/5 [=====] - 4s 780ms/step - loss: 0.5201 - acc:



0.8000 - val\_loss: 1.2410 - val\_acc: 0.4500  
 Epoch 148/200  
 5/5 [=====] - 4s 796ms/step - loss: 0.3043 - acc:  
 0.8750 - val\_loss: 0.9047 - val\_acc: 0.4500  
 Epoch 149/200  
 5/5 [=====] - 4s 779ms/step - loss: 0.4150 - acc:  
 0.8250 - val\_loss: 1.1770 - val\_acc: 0.5500  
 Epoch 150/200  
 5/5 [=====] - 4s 786ms/step - loss: 0.4592 - acc:  
 0.8000 - val\_loss: 0.9752 - val\_acc: 0.5500  
 Epoch 151/200  
 5/5 [=====] - 4s 783ms/step - loss: 0.4283 - acc:  
 0.7750 - val\_loss: 1.5029 - val\_acc: 0.5500  
 Epoch 152/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.4067 - acc:  
 0.8000 - val\_loss: 1.6103 - val\_acc: 0.4000  
 Epoch 153/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.5925 - acc:  
 0.8250 - val\_loss: 0.8230 - val\_acc: 0.2500  
 Epoch 154/200  
 5/5 [=====] - 4s 782ms/step - loss: 0.4490 - acc:  
 0.8000 - val\_loss: 1.0067 - val\_acc: 0.3500  
 Epoch 155/200  
 5/5 [=====] - 4s 799ms/step - loss: 0.3491 - acc:  
 0.8500 - val\_loss: 1.1941 - val\_acc: 0.3500  
 Epoch 156/200  
 5/5 [=====] - 4s 798ms/step - loss: 0.3413 - acc:  
 0.8500 - val\_loss: 1.5168 - val\_acc: 0.4000  
 Epoch 157/200  
 5/5 [=====] - 4s 797ms/step - loss: 0.3547 - acc:  
 0.8250 - val\_loss: 2.2053 - val\_acc: 0.5000  
 Epoch 158/200  
 5/5 [=====] - 4s 798ms/step - loss: 0.3812 - acc:  
 0.8250 - val\_loss: 2.4800 - val\_acc: 0.5000  
 Epoch 159/200  
 5/5 [=====] - 4s 799ms/step - loss: 0.3758 - acc:  
 0.8500 - val\_loss: 2.4885 - val\_acc: 0.6500  
 Epoch 160/200  
 5/5 [=====] - 4s 797ms/step - loss: 0.4440 - acc:  
 0.8000 - val\_loss: 1.6404 - val\_acc: 0.4500  
 Epoch 161/200  
 5/5 [=====] - 4s 793ms/step - loss: 0.3696 - acc:  
 0.8000 - val\_loss: 1.1918 - val\_acc: 0.3000  
 Epoch 162/200  
 5/5 [=====] - 4s 793ms/step - loss: 0.4206 - acc:  
 0.7500 - val\_loss: 1.8462 - val\_acc: 0.5000  
 Epoch 163/200  
 5/5 [=====] - 4s 792ms/step - loss: 0.4451 - acc:

0.7250 - val\_loss: 0.9609 - val\_acc: 0.5500  
Epoch 164/200  
5/5 [=====] - 4s 780ms/step - loss: 0.3578 - acc:  
0.8500 - val\_loss: 2.8912 - val\_acc: 0.5500  
Epoch 165/200  
5/5 [=====] - 4s 814ms/step - loss: 0.3884 - acc:  
0.8250 - val\_loss: 3.8800 - val\_acc: 0.2500  
Epoch 166/200  
5/5 [=====] - 4s 793ms/step - loss: 0.5488 - acc:  
0.8000 - val\_loss: 2.6412 - val\_acc: 0.3500  
Epoch 167/200  
5/5 [=====] - 4s 778ms/step - loss: 0.4837 - acc:  
0.8000 - val\_loss: 1.3122 - val\_acc: 0.5500  
Epoch 168/200  
5/5 [=====] - 4s 779ms/step - loss: 0.3677 - acc:  
0.8000 - val\_loss: 0.9641 - val\_acc: 0.5000  
Epoch 169/200  
5/5 [=====] - 4s 797ms/step - loss: 0.5952 - acc:  
0.7000 - val\_loss: 0.7904 - val\_acc: 0.5500  
Epoch 170/200  
5/5 [=====] - 4s 811ms/step - loss: 0.2965 - acc:  
0.9000 - val\_loss: 0.8101 - val\_acc: 0.5500  
Epoch 171/200  
5/5 [=====] - 4s 797ms/step - loss: 0.3411 - acc:  
0.8750 - val\_loss: 0.8290 - val\_acc: 0.4000  
Epoch 172/200  
5/5 [=====] - 4s 796ms/step - loss: 0.5688 - acc:  
0.7500 - val\_loss: 0.8655 - val\_acc: 0.5000  
Epoch 173/200  
5/5 [=====] - 4s 798ms/step - loss: 0.4115 - acc:  
0.8000 - val\_loss: 0.8828 - val\_acc: 0.6000  
Epoch 174/200  
5/5 [=====] - 4s 794ms/step - loss: 0.5331 - acc:  
0.7750 - val\_loss: 0.8871 - val\_acc: 0.5500  
Epoch 175/200  
5/5 [=====] - 4s 795ms/step - loss: 0.4257 - acc:  
0.8000 - val\_loss: 0.9895 - val\_acc: 0.4000  
Epoch 176/200  
5/5 [=====] - 4s 792ms/step - loss: 0.3369 - acc:  
0.8750 - val\_loss: 1.0708 - val\_acc: 0.4500  
Epoch 177/200  
5/5 [=====] - 4s 777ms/step - loss: 0.3227 - acc:  
0.8000 - val\_loss: 1.3030 - val\_acc: 0.4500  
Epoch 178/200  
5/5 [=====] - 4s 793ms/step - loss: 0.4392 - acc:  
0.7500 - val\_loss: 1.2796 - val\_acc: 0.4500  
Epoch 179/200  
5/5 [=====] - 4s 794ms/step - loss: 0.3168 - acc:

0.7750 - val\_loss: 0.9231 - val\_acc: 0.4500  
 Epoch 180/200  
 5/5 [=====] - 4s 778ms/step - loss: 0.3632 - acc:  
 0.8000 - val\_loss: 0.7960 - val\_acc: 0.6000  
 Epoch 181/200  
 5/5 [=====] - 4s 780ms/step - loss: 0.3391 - acc:  
 0.8000 - val\_loss: 0.8784 - val\_acc: 0.5500  
 Epoch 182/200  
 5/5 [=====] - 4s 780ms/step - loss: 0.3109 - acc:  
 0.8500 - val\_loss: 1.0568 - val\_acc: 0.5000  
 Epoch 183/200  
 5/5 [=====] - 4s 775ms/step - loss: 0.3971 - acc:  
 0.7500 - val\_loss: 0.6003 - val\_acc: 0.5500  
 Epoch 184/200  
 5/5 [=====] - 4s 786ms/step - loss: 0.2594 - acc:  
 0.8750 - val\_loss: 1.8821 - val\_acc: 0.4000  
 Epoch 185/200  
 5/5 [=====] - 4s 783ms/step - loss: 0.2831 - acc:  
 0.8000 - val\_loss: 2.3573 - val\_acc: 0.3500  
 Epoch 186/200  
 5/5 [=====] - 4s 783ms/step - loss: 0.4260 - acc:  
 0.7750 - val\_loss: 1.6932 - val\_acc: 0.4000  
 Epoch 187/200  
 5/5 [=====] - 4s 783ms/step - loss: 0.3569 - acc:  
 0.8500 - val\_loss: 1.3592 - val\_acc: 0.2500  
 Epoch 188/200  
 5/5 [=====] - 4s 780ms/step - loss: 0.4229 - acc:  
 0.9250 - val\_loss: 1.1614 - val\_acc: 0.4000  
 Epoch 189/200  
 5/5 [=====] - 4s 784ms/step - loss: 0.3703 - acc:  
 0.8750 - val\_loss: 0.7001 - val\_acc: 0.5000  
 Epoch 190/200  
 5/5 [=====] - 4s 797ms/step - loss: 0.3471 - acc:  
 0.8250 - val\_loss: 2.7587 - val\_acc: 0.4500  
 Epoch 191/200  
 5/5 [=====] - 4s 795ms/step - loss: 0.6667 - acc:  
 0.8250 - val\_loss: 1.2277 - val\_acc: 0.5500  
 Epoch 192/200  
 5/5 [=====] - 4s 785ms/step - loss: 0.4193 - acc:  
 0.8250 - val\_loss: 0.6388 - val\_acc: 0.6000  
 Epoch 193/200  
 5/5 [=====] - 4s 780ms/step - loss: 0.3773 - acc:  
 0.8250 - val\_loss: 0.5690 - val\_acc: 0.5500  
 Epoch 194/200  
 5/5 [=====] - 4s 783ms/step - loss: 0.6438 - acc:  
 0.7250 - val\_loss: 0.6986 - val\_acc: 0.4000  
 Epoch 195/200  
 5/5 [=====] - 4s 781ms/step - loss: 0.4494 - acc:

```

0.7500 - val_loss: 0.6771 - val_acc: 0.5000
Epoch 196/200
5/5 [=====] - 4s 778ms/step - loss: 0.4488 - acc:
0.8500 - val_loss: 0.8501 - val_acc: 0.4500
Epoch 197/200
5/5 [=====] - 4s 794ms/step - loss: 0.4148 - acc:
0.7750 - val_loss: 0.6343 - val_acc: 0.6500
Epoch 198/200
5/5 [=====] - 4s 795ms/step - loss: 0.3980 - acc:
0.8250 - val_loss: 0.8815 - val_acc: 0.5000
Epoch 199/200
5/5 [=====] - 4s 796ms/step - loss: 0.2581 - acc:
0.9000 - val_loss: 0.9529 - val_acc: 0.4500
Epoch 200/200
5/5 [=====] - 4s 797ms/step - loss: 0.2745 - acc:
0.9000 - val_loss: 1.4201 - val_acc: 0.5000

```

```

[44]: acc = history.history['acc']
      val_acc = history.history['val_acc']

      loss = history.history['loss']
      val_loss = history.history['val_loss']

      epochs = range(len(acc))

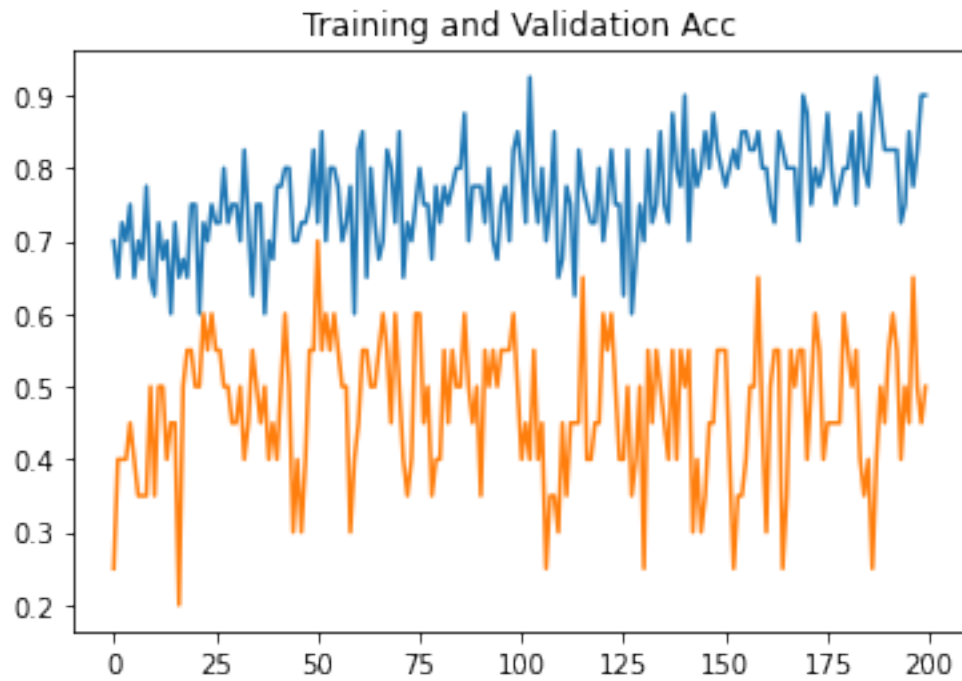
      plt.plot(epochs, acc)
      plt.plot(epochs, val_acc)
      plt.title('Training and Validation Acc')

```

```

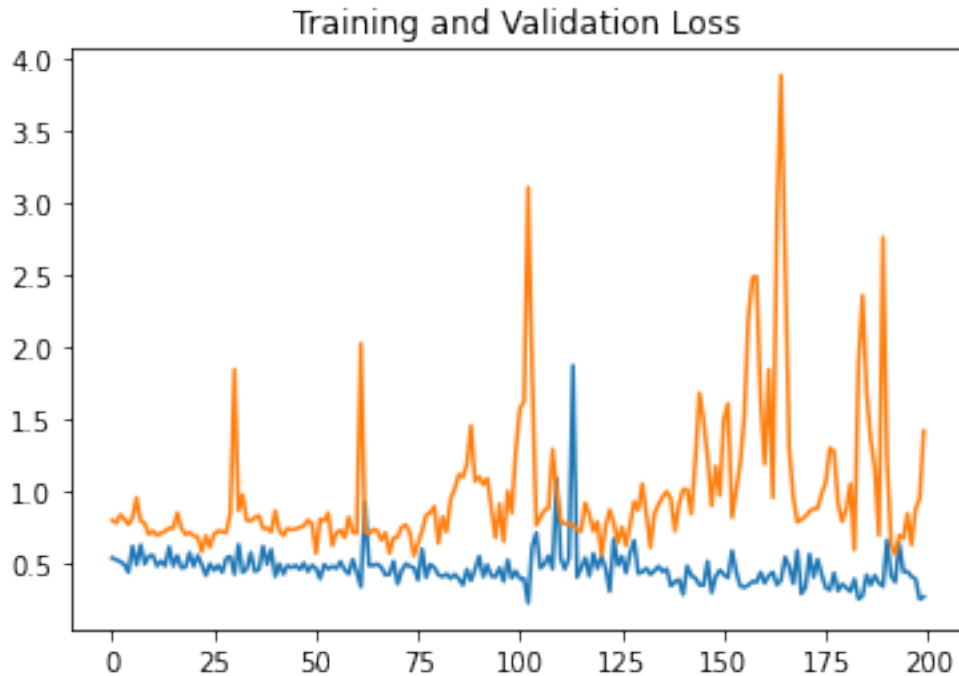
[44]: Text(0.5, 1.0, 'Training and Validation Acc')

```



```
[45]: plt.plot(epochs, loss)
      plt.plot(epochs, val_loss)
      plt.title('Training and Validation Loss')
```

```
[45]: Text(0.5, 1.0, 'Training and Validation Loss')
```



```
[46]: _, acc = model.evaluate_generator(test_data, steps=test_data.n, verbose=0)
      print('> %.3f' % (acc * 100.0))
```

> 51.000

```
[47]: history = model.fit_generator(train_data,
                                   epochs=300,
                                   validation_data=test_data,
                                   steps_per_epoch=train_data.n//batch_size,
                                   validation_steps=test_data.n//10,
                                   )
```

Epoch 1/300

5/5 [=====] - 4s 794ms/step - loss: 0.2811 - acc: 0.8500 - val\_loss: 1.6304 - val\_acc: 0.5000

Epoch 2/300

5/5 [=====] - 4s 781ms/step - loss: 0.2649 - acc: 0.8750 - val\_loss: 1.7160 - val\_acc: 0.5000

Epoch 3/300

5/5 [=====] - 4s 795ms/step - loss: 0.3566 - acc: 0.8500 - val\_loss: 2.1082 - val\_acc: 0.4500

Epoch 4/300

5/5 [=====] - 4s 779ms/step - loss: 0.1647 - acc: 0.9250 - val\_loss: 2.2792 - val\_acc: 0.5000

Epoch 5/300



5/5 [=====] - 4s 784ms/step - loss: 0.4824 - acc: 0.9000 - val\_loss: 4.5935 - val\_acc: 0.6500  
Epoch 6/300  
5/5 [=====] - 4s 781ms/step - loss: 0.3536 - acc: 0.8000 - val\_loss: 4.0645 - val\_acc: 0.6000  
Epoch 7/300  
5/5 [=====] - 4s 779ms/step - loss: 0.4735 - acc: 0.7500 - val\_loss: 0.8593 - val\_acc: 0.4000  
Epoch 8/300  
5/5 [=====] - 4s 801ms/step - loss: 0.3203 - acc: 0.9250 - val\_loss: 0.8252 - val\_acc: 0.4000  
Epoch 9/300  
5/5 [=====] - 4s 781ms/step - loss: 0.3594 - acc: 0.8000 - val\_loss: 0.8892 - val\_acc: 0.5000  
Epoch 10/300  
5/5 [=====] - 4s 781ms/step - loss: 0.7160 - acc: 0.6750 - val\_loss: 0.7269 - val\_acc: 0.5500  
Epoch 11/300  
5/5 [=====] - 4s 783ms/step - loss: 0.4294 - acc: 0.8000 - val\_loss: 0.7711 - val\_acc: 0.5000  
Epoch 12/300  
5/5 [=====] - 4s 811ms/step - loss: 0.3606 - acc: 0.8500 - val\_loss: 0.8595 - val\_acc: 0.4000  
Epoch 13/300  
5/5 [=====] - 4s 794ms/step - loss: 0.3879 - acc: 0.8250 - val\_loss: 0.7579 - val\_acc: 0.5000  
Epoch 14/300  
5/5 [=====] - 4s 779ms/step - loss: 0.4439 - acc: 0.7500 - val\_loss: 0.8361 - val\_acc: 0.6000  
Epoch 15/300  
5/5 [=====] - 4s 797ms/step - loss: 0.3223 - acc: 0.8500 - val\_loss: 1.8602 - val\_acc: 0.5500  
Epoch 16/300  
5/5 [=====] - 4s 778ms/step - loss: 0.2997 - acc: 0.8750 - val\_loss: 0.7900 - val\_acc: 0.6000  
Epoch 17/300  
5/5 [=====] - 4s 798ms/step - loss: 0.2330 - acc: 0.8750 - val\_loss: 4.1826 - val\_acc: 0.6000  
Epoch 18/300  
5/5 [=====] - 4s 782ms/step - loss: 0.4089 - acc: 0.8250 - val\_loss: 3.9370 - val\_acc: 0.6500  
Epoch 19/300  
5/5 [=====] - 4s 782ms/step - loss: 0.1891 - acc: 0.9000 - val\_loss: 1.7660 - val\_acc: 0.5000  
Epoch 20/300  
5/5 [=====] - 4s 775ms/step - loss: 0.4893 - acc: 0.7750 - val\_loss: 1.6018 - val\_acc: 0.6500  
Epoch 21/300

5/5 [=====] - 4s 781ms/step - loss: 0.3989 - acc:  
 0.8000 - val\_loss: 2.0860 - val\_acc: 0.5000  
 Epoch 22/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.3010 - acc:  
 0.8500 - val\_loss: 1.9135 - val\_acc: 0.6000  
 Epoch 23/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.2529 - acc:  
 0.9000 - val\_loss: 1.3039 - val\_acc: 0.5000  
 Epoch 24/300  
 5/5 [=====] - 4s 794ms/step - loss: 0.2215 - acc:  
 0.9000 - val\_loss: 1.7625 - val\_acc: 0.4500  
 Epoch 25/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.3453 - acc:  
 0.8250 - val\_loss: 1.0852 - val\_acc: 0.4500  
 Epoch 26/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.2697 - acc:  
 0.8750 - val\_loss: 0.8805 - val\_acc: 0.4500  
 Epoch 27/300  
 5/5 [=====] - 4s 794ms/step - loss: 0.3898 - acc:  
 0.7750 - val\_loss: 1.0542 - val\_acc: 0.4000  
 Epoch 28/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.2586 - acc:  
 0.8750 - val\_loss: 0.9721 - val\_acc: 0.5500  
 Epoch 29/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.2457 - acc:  
 0.8750 - val\_loss: 1.6890 - val\_acc: 0.4500  
 Epoch 30/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.3155 - acc:  
 0.8000 - val\_loss: 1.2906 - val\_acc: 0.4000  
 Epoch 31/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.3584 - acc:  
 0.7750 - val\_loss: 1.5908 - val\_acc: 0.4500  
 Epoch 32/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.3247 - acc:  
 0.8250 - val\_loss: 1.1659 - val\_acc: 0.4500  
 Epoch 33/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.3816 - acc:  
 0.8500 - val\_loss: 1.1414 - val\_acc: 0.4500  
 Epoch 34/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.4044 - acc:  
 0.7750 - val\_loss: 1.2112 - val\_acc: 0.4000  
 Epoch 35/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.2607 - acc:  
 0.8750 - val\_loss: 1.1657 - val\_acc: 0.4500  
 Epoch 36/300  
 5/5 [=====] - 4s 777ms/step - loss: 0.2445 - acc:  
 0.8750 - val\_loss: 1.1270 - val\_acc: 0.4000  
 Epoch 37/300

5/5 [=====] - 4s 778ms/step - loss: 0.2460 - acc:  
0.8500 - val\_loss: 1.3963 - val\_acc: 0.4500  
Epoch 38/300  
5/5 [=====] - 4s 816ms/step - loss: 0.2178 - acc:  
0.9000 - val\_loss: 0.7118 - val\_acc: 0.5500  
Epoch 39/300  
5/5 [=====] - 4s 783ms/step - loss: 0.2709 - acc:  
0.9000 - val\_loss: 2.6007 - val\_acc: 0.5000  
Epoch 40/300  
5/5 [=====] - 4s 780ms/step - loss: 0.1360 - acc:  
0.9500 - val\_loss: 2.7325 - val\_acc: 0.6000  
Epoch 41/300  
5/5 [=====] - 4s 794ms/step - loss: 0.3512 - acc:  
0.9250 - val\_loss: 1.6221 - val\_acc: 0.5000  
Epoch 42/300  
5/5 [=====] - 4s 794ms/step - loss: 0.1792 - acc:  
0.9250 - val\_loss: 1.2762 - val\_acc: 0.3500  
Epoch 43/300  
5/5 [=====] - 4s 796ms/step - loss: 0.3743 - acc:  
0.8500 - val\_loss: 1.5207 - val\_acc: 0.4500  
Epoch 44/300  
5/5 [=====] - 4s 795ms/step - loss: 0.2895 - acc:  
0.9000 - val\_loss: 0.7241 - val\_acc: 0.7000  
Epoch 45/300  
5/5 [=====] - 4s 781ms/step - loss: 0.2340 - acc:  
0.8750 - val\_loss: 1.3311 - val\_acc: 0.5000  
Epoch 46/300  
5/5 [=====] - 4s 792ms/step - loss: 0.3049 - acc:  
0.8500 - val\_loss: 1.5920 - val\_acc: 0.3500  
Epoch 47/300  
5/5 [=====] - 4s 779ms/step - loss: 0.2735 - acc:  
0.9250 - val\_loss: 1.7148 - val\_acc: 0.4000  
Epoch 48/300  
5/5 [=====] - 4s 783ms/step - loss: 0.2527 - acc:  
0.8750 - val\_loss: 1.4856 - val\_acc: 0.4500  
Epoch 49/300  
5/5 [=====] - 4s 778ms/step - loss: 0.5642 - acc:  
0.9000 - val\_loss: 1.0630 - val\_acc: 0.4500  
Epoch 50/300  
5/5 [=====] - 4s 795ms/step - loss: 0.2463 - acc:  
0.9000 - val\_loss: 1.0724 - val\_acc: 0.4500  
Epoch 51/300  
5/5 [=====] - 4s 795ms/step - loss: 0.2968 - acc:  
0.8250 - val\_loss: 1.1235 - val\_acc: 0.5000  
Epoch 52/300  
5/5 [=====] - 4s 794ms/step - loss: 0.2649 - acc:  
0.8500 - val\_loss: 1.4542 - val\_acc: 0.5500  
Epoch 53/300

5/5 [=====] - 4s 776ms/step - loss: 0.2565 - acc:  
 0.8500 - val\_loss: 1.6477 - val\_acc: 0.5000  
 Epoch 54/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.2525 - acc:  
 0.9000 - val\_loss: 0.8492 - val\_acc: 0.5000  
 Epoch 55/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.3059 - acc:  
 0.8500 - val\_loss: 1.2592 - val\_acc: 0.5000  
 Epoch 56/300  
 5/5 [=====] - 4s 777ms/step - loss: 0.3990 - acc:  
 0.8500 - val\_loss: 2.5157 - val\_acc: 0.4500  
 Epoch 57/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.9086 - acc:  
 0.7750 - val\_loss: 3.3194 - val\_acc: 0.4500  
 Epoch 58/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.2952 - acc:  
 0.9000 - val\_loss: 5.5897 - val\_acc: 0.3500  
 Epoch 59/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.2158 - acc:  
 0.9250 - val\_loss: 2.6614 - val\_acc: 0.3500  
 Epoch 60/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.2676 - acc:  
 0.8500 - val\_loss: 1.6244 - val\_acc: 0.3000  
 Epoch 61/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.3054 - acc:  
 0.8500 - val\_loss: 2.6373 - val\_acc: 0.4500  
 Epoch 62/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.3701 - acc:  
 0.7750 - val\_loss: 3.7713 - val\_acc: 0.5000  
 Epoch 63/300  
 5/5 [=====] - 4s 794ms/step - loss: 0.2405 - acc:  
 0.9250 - val\_loss: 6.1615 - val\_acc: 0.4000  
 Epoch 64/300  
 5/5 [=====] - 4s 816ms/step - loss: 0.3587 - acc:  
 0.8250 - val\_loss: 0.4705 - val\_acc: 0.6500  
 Epoch 65/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.2899 - acc:  
 0.8250 - val\_loss: 0.5987 - val\_acc: 0.6000  
 Epoch 66/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.3876 - acc:  
 0.8250 - val\_loss: 0.6199 - val\_acc: 0.5500  
 Epoch 67/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.4305 - acc:  
 0.8000 - val\_loss: 0.6534 - val\_acc: 0.5500  
 Epoch 68/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.4040 - acc:  
 0.7250 - val\_loss: 0.7052 - val\_acc: 0.5500  
 Epoch 69/300

5/5 [=====] - 4s 780ms/step - loss: 0.3274 - acc:  
 0.8250 - val\_loss: 0.6823 - val\_acc: 0.5500  
 Epoch 70/300  
 5/5 [=====] - 4s 794ms/step - loss: 0.4138 - acc:  
 0.7500 - val\_loss: 0.7791 - val\_acc: 0.5000  
 Epoch 71/300  
 5/5 [=====] - 4s 817ms/step - loss: 0.4465 - acc:  
 0.8250 - val\_loss: 0.6858 - val\_acc: 0.4500  
 Epoch 72/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.2861 - acc:  
 0.8500 - val\_loss: 0.7132 - val\_acc: 0.4500  
 Epoch 73/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.4740 - acc:  
 0.8250 - val\_loss: 0.6271 - val\_acc: 0.5500  
 Epoch 74/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.4185 - acc:  
 0.8750 - val\_loss: 0.6046 - val\_acc: 0.5500  
 Epoch 75/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.3416 - acc:  
 0.8250 - val\_loss: 0.6064 - val\_acc: 0.5500  
 Epoch 76/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.2813 - acc:  
 0.8750 - val\_loss: 0.7231 - val\_acc: 0.5000  
 Epoch 77/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.4001 - acc:  
 0.9000 - val\_loss: 0.6234 - val\_acc: 0.5500  
 Epoch 78/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.2180 - acc:  
 0.9250 - val\_loss: 0.4994 - val\_acc: 0.7000  
 Epoch 79/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.4180 - acc:  
 0.8500 - val\_loss: 0.6862 - val\_acc: 0.7000  
 Epoch 80/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.4204 - acc:  
 0.8000 - val\_loss: 0.6069 - val\_acc: 0.6500  
 Epoch 81/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.2268 - acc:  
 0.9000 - val\_loss: 0.6194 - val\_acc: 0.6000  
 Epoch 82/300  
 5/5 [=====] - 4s 776ms/step - loss: 0.2876 - acc:  
 0.8500 - val\_loss: 0.4767 - val\_acc: 0.7500  
 Epoch 83/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.2814 - acc:  
 0.8750 - val\_loss: 0.8095 - val\_acc: 0.5500  
 Epoch 84/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.5033 - acc:  
 0.8250 - val\_loss: 0.7921 - val\_acc: 0.5000  
 Epoch 85/300

5/5 [=====] - 4s 796ms/step - loss: 0.2974 - acc:  
 0.8500 - val\_loss: 0.7440 - val\_acc: 0.5500  
 Epoch 86/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.3366 - acc:  
 0.8500 - val\_loss: 0.7005 - val\_acc: 0.5500  
 Epoch 87/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.3400 - acc:  
 0.8500 - val\_loss: 2.6399 - val\_acc: 0.5000  
 Epoch 88/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.3261 - acc:  
 0.8500 - val\_loss: 0.4598 - val\_acc: 0.6000  
 Epoch 89/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.3169 - acc:  
 0.8000 - val\_loss: 0.7428 - val\_acc: 0.5000  
 Epoch 90/300  
 5/5 [=====] - 4s 817ms/step - loss: 0.2367 - acc:  
 0.8750 - val\_loss: 0.8965 - val\_acc: 0.5000  
 Epoch 91/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.3758 - acc:  
 0.8500 - val\_loss: 0.6882 - val\_acc: 0.5000  
 Epoch 92/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.2229 - acc:  
 0.9250 - val\_loss: 0.9315 - val\_acc: 0.4500  
 Epoch 93/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.3134 - acc:  
 0.8500 - val\_loss: 3.2440 - val\_acc: 0.5500  
 Epoch 94/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.4844 - acc:  
 0.7750 - val\_loss: 4.5147 - val\_acc: 0.5500  
 Epoch 95/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.2504 - acc:  
 0.8750 - val\_loss: 5.7935 - val\_acc: 0.5500  
 Epoch 96/300  
 5/5 [=====] - 4s 784ms/step - loss: 0.2726 - acc:  
 0.8250 - val\_loss: 5.0521 - val\_acc: 0.6000  
 Epoch 97/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.2185 - acc:  
 0.8750 - val\_loss: 2.5644 - val\_acc: 0.5000  
 Epoch 98/300  
 5/5 [=====] - 4s 794ms/step - loss: 0.2237 - acc:  
 0.8500 - val\_loss: 1.1123 - val\_acc: 0.4500  
 Epoch 99/300  
 5/5 [=====] - 4s 793ms/step - loss: 0.2107 - acc:  
 0.9250 - val\_loss: 0.7566 - val\_acc: 0.6000  
 Epoch 100/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.1784 - acc:  
 0.9500 - val\_loss: 0.8077 - val\_acc: 0.5000  
 Epoch 101/300

5/5 [=====] - 4s 783ms/step - loss: 0.2976 - acc:  
 0.8500 - val\_loss: 0.7272 - val\_acc: 0.5500  
 Epoch 102/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.2667 - acc:  
 0.8750 - val\_loss: 0.5618 - val\_acc: 0.5500  
 Epoch 103/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.2464 - acc:  
 0.8500 - val\_loss: 0.7771 - val\_acc: 0.5500  
 Epoch 104/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.2130 - acc:  
 0.8750 - val\_loss: 1.1848 - val\_acc: 0.5000  
 Epoch 105/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.1770 - acc:  
 0.9250 - val\_loss: 1.6767 - val\_acc: 0.4500  
 Epoch 106/300  
 5/5 [=====] - 4s 794ms/step - loss: 0.4273 - acc:  
 0.8500 - val\_loss: 2.6779 - val\_acc: 0.3500  
 Epoch 107/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.2330 - acc:  
 0.9250 - val\_loss: 2.5185 - val\_acc: 0.5000  
 Epoch 108/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.3120 - acc:  
 0.8500 - val\_loss: 1.2210 - val\_acc: 0.4000  
 Epoch 109/300  
 5/5 [=====] - 4s 794ms/step - loss: 0.1505 - acc:  
 0.9500 - val\_loss: 1.9777 - val\_acc: 0.4500  
 Epoch 110/300  
 5/5 [=====] - 4s 793ms/step - loss: 0.3179 - acc:  
 0.8750 - val\_loss: 1.4471 - val\_acc: 0.5500  
 Epoch 111/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.5059 - acc:  
 0.8250 - val\_loss: 0.6851 - val\_acc: 0.5500  
 Epoch 112/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.2755 - acc:  
 0.8750 - val\_loss: 0.6484 - val\_acc: 0.6500  
 Epoch 113/300  
 5/5 [=====] - 4s 784ms/step - loss: 0.2797 - acc:  
 0.8750 - val\_loss: 0.9513 - val\_acc: 0.5000  
 Epoch 114/300  
 5/5 [=====] - 4s 794ms/step - loss: 1.1114 - acc:  
 0.8500 - val\_loss: 0.7975 - val\_acc: 0.5500  
 Epoch 115/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.2960 - acc:  
 0.8500 - val\_loss: 1.4526 - val\_acc: 0.4000  
 Epoch 116/300  
 5/5 [=====] - 4s 815ms/step - loss: 0.2713 - acc:  
 0.8500 - val\_loss: 1.9460 - val\_acc: 0.4000  
 Epoch 117/300

5/5 [=====] - 4s 781ms/step - loss: 0.2393 - acc:  
 0.9000 - val\_loss: 2.0583 - val\_acc: 0.4000  
 Epoch 118/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.2673 - acc:  
 0.9000 - val\_loss: 2.6325 - val\_acc: 0.5000  
 Epoch 119/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.5967 - acc:  
 0.8750 - val\_loss: 1.1913 - val\_acc: 0.3500  
 Epoch 120/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.1914 - acc:  
 0.9250 - val\_loss: 1.1948 - val\_acc: 0.4500  
 Epoch 121/300  
 5/5 [=====] - 4s 798ms/step - loss: 0.3775 - acc:  
 0.8000 - val\_loss: 0.9627 - val\_acc: 0.5000  
 Epoch 122/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.2205 - acc:  
 0.9250 - val\_loss: 0.8122 - val\_acc: 0.4500  
 Epoch 123/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.3984 - acc:  
 0.8250 - val\_loss: 0.7747 - val\_acc: 0.5000  
 Epoch 124/300  
 5/5 [=====] - 4s 794ms/step - loss: 0.2542 - acc:  
 0.9000 - val\_loss: 0.7256 - val\_acc: 0.4000  
 Epoch 125/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.2400 - acc:  
 0.8750 - val\_loss: 0.6702 - val\_acc: 0.5000  
 Epoch 126/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.2918 - acc:  
 0.9250 - val\_loss: 0.6844 - val\_acc: 0.4000  
 Epoch 127/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.4307 - acc:  
 0.7750 - val\_loss: 0.6810 - val\_acc: 0.5000  
 Epoch 128/300  
 5/5 [=====] - 4s 799ms/step - loss: 0.2931 - acc:  
 0.9000 - val\_loss: 0.6654 - val\_acc: 0.5500  
 Epoch 129/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.1972 - acc:  
 0.9750 - val\_loss: 0.7947 - val\_acc: 0.5000  
 Epoch 130/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.2181 - acc:  
 0.8750 - val\_loss: 0.6306 - val\_acc: 0.5500  
 Epoch 131/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.2369 - acc:  
 0.8750 - val\_loss: 1.5144 - val\_acc: 0.5500  
 Epoch 132/300  
 5/5 [=====] - 4s 793ms/step - loss: 0.1719 - acc:  
 0.9000 - val\_loss: 2.4740 - val\_acc: 0.4500  
 Epoch 133/300



5/5 [=====] - 4s 794ms/step - loss: 0.4369 - acc:  
 0.8250 - val\_loss: 2.9453 - val\_acc: 0.5000  
 Epoch 134/300  
 5/5 [=====] - 4s 786ms/step - loss: 0.2120 - acc:  
 0.9000 - val\_loss: 0.6041 - val\_acc: 0.7000  
 Epoch 135/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.4415 - acc:  
 0.7750 - val\_loss: 0.5987 - val\_acc: 0.6000  
 Epoch 136/300  
 5/5 [=====] - 4s 793ms/step - loss: 0.2627 - acc:  
 0.8750 - val\_loss: 0.5024 - val\_acc: 0.6500  
 Epoch 137/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.4605 - acc:  
 0.7750 - val\_loss: 0.6312 - val\_acc: 0.5500  
 Epoch 138/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.4013 - acc:  
 0.8500 - val\_loss: 0.7265 - val\_acc: 0.5000  
 Epoch 139/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.2320 - acc:  
 0.9250 - val\_loss: 1.1001 - val\_acc: 0.4500  
 Epoch 140/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.2317 - acc:  
 0.9250 - val\_loss: 0.7935 - val\_acc: 0.6500  
 Epoch 141/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.1920 - acc:  
 0.9500 - val\_loss: 3.0423 - val\_acc: 0.5000  
 Epoch 142/300  
 5/5 [=====] - 4s 831ms/step - loss: 0.2266 - acc:  
 0.9000 - val\_loss: 0.7683 - val\_acc: 0.6500  
 Epoch 143/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.1388 - acc:  
 0.9500 - val\_loss: 5.6149 - val\_acc: 0.5500  
 Epoch 144/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.1811 - acc:  
 0.9250 - val\_loss: 6.2938 - val\_acc: 0.5500  
 Epoch 145/300  
 5/5 [=====] - 4s 799ms/step - loss: 0.1872 - acc:  
 0.9500 - val\_loss: 6.0002 - val\_acc: 0.5000  
 Epoch 146/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.2383 - acc:  
 0.8750 - val\_loss: 7.9422 - val\_acc: 0.4500  
 Epoch 147/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.2294 - acc:  
 0.8750 - val\_loss: 2.4422 - val\_acc: 0.5500  
 Epoch 148/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.2537 - acc:  
 0.8500 - val\_loss: 1.8608 - val\_acc: 0.6000  
 Epoch 149/300

5/5 [=====] - 4s 784ms/step - loss: 0.1551 - acc:  
 0.9250 - val\_loss: 1.3341 - val\_acc: 0.6500  
 Epoch 150/300  
 5/5 [=====] - 4s 798ms/step - loss: 0.1939 - acc:  
 0.9500 - val\_loss: 3.0347 - val\_acc: 0.6500  
 Epoch 151/300  
 5/5 [=====] - 4s 798ms/step - loss: 0.7563 - acc:  
 0.8250 - val\_loss: 5.0196 - val\_acc: 0.5000  
 Epoch 152/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.2722 - acc:  
 0.9000 - val\_loss: 5.5183 - val\_acc: 0.5500  
 Epoch 153/300  
 5/5 [=====] - 4s 784ms/step - loss: 0.3659 - acc:  
 0.8750 - val\_loss: 5.0803 - val\_acc: 0.5000  
 Epoch 154/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.2793 - acc:  
 0.8250 - val\_loss: 4.6211 - val\_acc: 0.5000  
 Epoch 155/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.2455 - acc:  
 0.8750 - val\_loss: 3.3310 - val\_acc: 0.5500  
 Epoch 156/300  
 5/5 [=====] - 4s 784ms/step - loss: 0.2598 - acc:  
 0.8750 - val\_loss: 0.8813 - val\_acc: 0.5500  
 Epoch 157/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.2781 - acc:  
 0.8500 - val\_loss: 1.9223 - val\_acc: 0.5000  
 Epoch 158/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.2614 - acc:  
 0.9000 - val\_loss: 4.3848 - val\_acc: 0.7500  
 Epoch 159/300  
 5/5 [=====] - 4s 791ms/step - loss: 0.2406 - acc:  
 0.9000 - val\_loss: 3.8797 - val\_acc: 0.5500  
 Epoch 160/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.2867 - acc:  
 0.8250 - val\_loss: 7.3217 - val\_acc: 0.5000  
 Epoch 161/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.1860 - acc:  
 0.9000 - val\_loss: 3.5514 - val\_acc: 0.5500  
 Epoch 162/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.2589 - acc:  
 0.9000 - val\_loss: 1.1380 - val\_acc: 0.6000  
 Epoch 163/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.3535 - acc:  
 0.9000 - val\_loss: 2.6546 - val\_acc: 0.6000  
 Epoch 164/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.1910 - acc:  
 0.9250 - val\_loss: 5.5556 - val\_acc: 0.5000  
 Epoch 165/300

5/5 [=====] - 4s 780ms/step - loss: 0.1984 - acc:  
 0.9250 - val\_loss: 4.0794 - val\_acc: 0.5500  
 Epoch 166/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.1411 - acc:  
 0.9500 - val\_loss: 1.5712 - val\_acc: 0.6500  
 Epoch 167/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.2558 - acc:  
 0.9250 - val\_loss: 5.6324 - val\_acc: 0.5000  
 Epoch 168/300  
 5/5 [=====] - 4s 798ms/step - loss: 0.1932 - acc:  
 0.9250 - val\_loss: 7.8724 - val\_acc: 0.4500  
 Epoch 169/300  
 5/5 [=====] - 4s 791ms/step - loss: 0.3351 - acc:  
 0.8000 - val\_loss: 6.2436 - val\_acc: 0.5500  
 Epoch 170/300  
 5/5 [=====] - 4s 798ms/step - loss: 0.1731 - acc:  
 0.9250 - val\_loss: 2.4492 - val\_acc: 0.5000  
 Epoch 171/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.1886 - acc:  
 0.9000 - val\_loss: 1.0451 - val\_acc: 0.5500  
 Epoch 172/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.3148 - acc:  
 0.9000 - val\_loss: 0.4605 - val\_acc: 0.7000  
 Epoch 173/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.1467 - acc:  
 0.9250 - val\_loss: 0.8059 - val\_acc: 0.7500  
 Epoch 174/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.2493 - acc:  
 0.8750 - val\_loss: 1.1014 - val\_acc: 0.6500  
 Epoch 175/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.3388 - acc:  
 0.8000 - val\_loss: 1.4124 - val\_acc: 0.7000  
 Epoch 176/300  
 5/5 [=====] - 4s 800ms/step - loss: 0.1750 - acc:  
 0.9750 - val\_loss: 3.2661 - val\_acc: 0.7000  
 Epoch 177/300  
 5/5 [=====] - 4s 785ms/step - loss: 0.1790 - acc:  
 0.8750 - val\_loss: 5.4520 - val\_acc: 0.6000  
 Epoch 178/300  
 5/5 [=====] - 4s 792ms/step - loss: 0.3327 - acc:  
 0.8750 - val\_loss: 7.9589 - val\_acc: 0.5000  
 Epoch 179/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.2297 - acc:  
 0.8750 - val\_loss: 3.1977 - val\_acc: 0.6000  
 Epoch 180/300  
 5/5 [=====] - 4s 801ms/step - loss: 0.1256 - acc:  
 0.9750 - val\_loss: 4.0763 - val\_acc: 0.5000  
 Epoch 181/300

5/5 [=====] - 4s 784ms/step - loss: 0.1351 - acc:  
 0.9750 - val\_loss: 3.1392 - val\_acc: 0.5500  
 Epoch 182/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.1417 - acc:  
 0.9500 - val\_loss: 3.9044 - val\_acc: 0.6000  
 Epoch 183/300  
 5/5 [=====] - 4s 787ms/step - loss: 0.1521 - acc:  
 0.9750 - val\_loss: 4.3021 - val\_acc: 0.5500  
 Epoch 184/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.3399 - acc:  
 0.8750 - val\_loss: 1.7781 - val\_acc: 0.5500  
 Epoch 185/300  
 5/5 [=====] - 4s 784ms/step - loss: 0.1368 - acc:  
 0.9500 - val\_loss: 5.5281 - val\_acc: 0.5500  
 Epoch 186/300  
 5/5 [=====] - 4s 784ms/step - loss: 0.2433 - acc:  
 0.9000 - val\_loss: 0.9906 - val\_acc: 0.6500  
 Epoch 187/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.1882 - acc:  
 0.9250 - val\_loss: 7.4949 - val\_acc: 0.5000  
 Epoch 188/300  
 5/5 [=====] - 4s 790ms/step - loss: 0.2308 - acc:  
 0.9250 - val\_loss: 0.8037 - val\_acc: 0.6000  
 Epoch 189/300  
 5/5 [=====] - 4s 793ms/step - loss: 0.3281 - acc:  
 0.8250 - val\_loss: 1.0618 - val\_acc: 0.5500  
 Epoch 190/300  
 5/5 [=====] - 4s 794ms/step - loss: 0.1928 - acc:  
 0.9250 - val\_loss: 0.6851 - val\_acc: 0.6500  
 Epoch 191/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.2950 - acc:  
 0.8250 - val\_loss: 0.7199 - val\_acc: 0.6000  
 Epoch 192/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.2078 - acc:  
 0.9250 - val\_loss: 0.5963 - val\_acc: 0.7500  
 Epoch 193/300  
 5/5 [=====] - 4s 813ms/step - loss: 0.3100 - acc:  
 0.8250 - val\_loss: 0.7189 - val\_acc: 0.5500  
 Epoch 194/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.1766 - acc:  
 0.9250 - val\_loss: 0.6110 - val\_acc: 0.5500  
 Epoch 195/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.2026 - acc:  
 0.9000 - val\_loss: 0.9037 - val\_acc: 0.5500  
 Epoch 196/300  
 5/5 [=====] - 4s 792ms/step - loss: 0.1767 - acc:  
 0.9500 - val\_loss: 1.2870 - val\_acc: 0.5000  
 Epoch 197/300

5/5 [=====] - 4s 795ms/step - loss: 0.1090 - acc:  
 0.9500 - val\_loss: 2.1902 - val\_acc: 0.5000  
 Epoch 198/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.1605 - acc:  
 0.9000 - val\_loss: 2.6307 - val\_acc: 0.3500  
 Epoch 199/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.1365 - acc:  
 0.9250 - val\_loss: 4.4014 - val\_acc: 0.5000  
 Epoch 200/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.1705 - acc:  
 0.9500 - val\_loss: 2.6358 - val\_acc: 0.5500  
 Epoch 201/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.1051 - acc:  
 0.9500 - val\_loss: 2.5288 - val\_acc: 0.4500  
 Epoch 202/300  
 5/5 [=====] - 4s 814ms/step - loss: 0.2097 - acc:  
 0.9250 - val\_loss: 3.7089 - val\_acc: 0.5000  
 Epoch 203/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.1158 - acc:  
 0.9250 - val\_loss: 3.4560 - val\_acc: 0.5000  
 Epoch 204/300  
 5/5 [=====] - 4s 800ms/step - loss: 0.1544 - acc:  
 0.9500 - val\_loss: 1.6035 - val\_acc: 0.5500  
 Epoch 205/300  
 5/5 [=====] - 4s 784ms/step - loss: 0.3303 - acc:  
 0.9000 - val\_loss: 1.8782 - val\_acc: 0.5000  
 Epoch 206/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.1792 - acc:  
 0.9500 - val\_loss: 2.1973 - val\_acc: 0.4500  
 Epoch 207/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.2032 - acc:  
 0.9000 - val\_loss: 1.8845 - val\_acc: 0.5500  
 Epoch 208/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.1173 - acc:  
 0.9250 - val\_loss: 2.6702 - val\_acc: 0.4500  
 Epoch 209/300  
 5/5 [=====] - 4s 784ms/step - loss: 0.1873 - acc:  
 0.9250 - val\_loss: 2.3471 - val\_acc: 0.5500  
 Epoch 210/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.1424 - acc:  
 0.9500 - val\_loss: 3.1296 - val\_acc: 0.5500  
 Epoch 211/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.1271 - acc:  
 0.9750 - val\_loss: 2.2749 - val\_acc: 0.6000  
 Epoch 212/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.5140 - acc:  
 0.8500 - val\_loss: 1.0355 - val\_acc: 0.7500  
 Epoch 213/300

5/5 [=====] - 4s 782ms/step - loss: 0.1737 - acc:  
0.9250 - val\_loss: 1.2004 - val\_acc: 0.5500  
Epoch 214/300  
5/5 [=====] - 4s 780ms/step - loss: 0.2693 - acc:  
0.9000 - val\_loss: 0.7420 - val\_acc: 0.6500  
Epoch 215/300  
5/5 [=====] - 4s 792ms/step - loss: 0.5141 - acc:  
0.8250 - val\_loss: 1.2626 - val\_acc: 0.4000  
Epoch 216/300  
5/5 [=====] - 4s 793ms/step - loss: 0.1859 - acc:  
0.9250 - val\_loss: 1.9196 - val\_acc: 0.5500  
Epoch 217/300  
5/5 [=====] - 4s 797ms/step - loss: 0.3032 - acc:  
0.8500 - val\_loss: 5.7324 - val\_acc: 0.5000  
Epoch 218/300  
5/5 [=====] - 4s 781ms/step - loss: 0.2261 - acc:  
0.9000 - val\_loss: 4.3801 - val\_acc: 0.6500  
Epoch 219/300  
5/5 [=====] - 4s 797ms/step - loss: 0.1753 - acc:  
0.9000 - val\_loss: 2.6922 - val\_acc: 0.5500  
Epoch 220/300  
5/5 [=====] - 4s 783ms/step - loss: 0.3185 - acc:  
0.8250 - val\_loss: 3.6904 - val\_acc: 0.4500  
Epoch 221/300  
5/5 [=====] - 4s 783ms/step - loss: 0.1807 - acc:  
0.9000 - val\_loss: 2.0226 - val\_acc: 0.5500  
Epoch 222/300  
5/5 [=====] - 4s 798ms/step - loss: 0.2029 - acc:  
0.9000 - val\_loss: 3.1352 - val\_acc: 0.5500  
Epoch 223/300  
5/5 [=====] - 4s 792ms/step - loss: 0.2008 - acc:  
0.9250 - val\_loss: 2.2546 - val\_acc: 0.6000  
Epoch 224/300  
5/5 [=====] - 4s 779ms/step - loss: 0.2383 - acc:  
0.9000 - val\_loss: 4.6198 - val\_acc: 0.5000  
Epoch 225/300  
5/5 [=====] - 4s 798ms/step - loss: 0.1081 - acc:  
0.9750 - val\_loss: 3.2084 - val\_acc: 0.6000  
Epoch 226/300  
5/5 [=====] - 4s 796ms/step - loss: 0.1426 - acc:  
0.9250 - val\_loss: 4.4482 - val\_acc: 0.4500  
Epoch 227/300  
5/5 [=====] - 4s 796ms/step - loss: 0.1422 - acc:  
0.9750 - val\_loss: 5.2327 - val\_acc: 0.5500  
Epoch 228/300  
5/5 [=====] - 4s 794ms/step - loss: 0.1557 - acc:  
0.9000 - val\_loss: 0.9814 - val\_acc: 0.6000  
Epoch 229/300

5/5 [=====] - 4s 783ms/step - loss: 0.2118 - acc:  
 0.9000 - val\_loss: 6.4113 - val\_acc: 0.5500  
 Epoch 230/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.1217 - acc:  
 0.9500 - val\_loss: 6.3093 - val\_acc: 0.5500  
 Epoch 231/300  
 5/5 [=====] - 4s 790ms/step - loss: 0.1440 - acc:  
 0.9250 - val\_loss: 5.0884 - val\_acc: 0.5000  
 Epoch 232/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.1410 - acc:  
 0.9000 - val\_loss: 3.7365 - val\_acc: 0.4000  
 Epoch 233/300  
 5/5 [=====] - 4s 794ms/step - loss: 0.1017 - acc:  
 1.0000 - val\_loss: 3.6589 - val\_acc: 0.4500  
 Epoch 234/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.2125 - acc:  
 0.9000 - val\_loss: 6.4209 - val\_acc: 0.4000  
 Epoch 235/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.1490 - acc:  
 0.9500 - val\_loss: 4.5602 - val\_acc: 0.4500  
 Epoch 236/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.1922 - acc:  
 0.9250 - val\_loss: 5.1951 - val\_acc: 0.5000  
 Epoch 237/300  
 5/5 [=====] - 4s 784ms/step - loss: 0.1281 - acc:  
 0.9750 - val\_loss: 4.9484 - val\_acc: 0.4500  
 Epoch 238/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.1323 - acc:  
 0.9500 - val\_loss: 1.7361 - val\_acc: 0.5500  
 Epoch 239/300  
 5/5 [=====] - 4s 796ms/step - loss: 0.0678 - acc:  
 1.0000 - val\_loss: 5.0300 - val\_acc: 0.4500  
 Epoch 240/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.2150 - acc:  
 0.9000 - val\_loss: 0.9190 - val\_acc: 0.6500  
 Epoch 241/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.2731 - acc:  
 0.8750 - val\_loss: 1.7293 - val\_acc: 0.5500  
 Epoch 242/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.1087 - acc:  
 0.9750 - val\_loss: 1.5706 - val\_acc: 0.5500  
 Epoch 243/300  
 5/5 [=====] - 4s 793ms/step - loss: 0.1671 - acc:  
 0.9250 - val\_loss: 1.2417 - val\_acc: 0.5500  
 Epoch 244/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.2275 - acc:  
 0.8750 - val\_loss: 1.1436 - val\_acc: 0.6000  
 Epoch 245/300

5/5 [=====] - 4s 794ms/step - loss: 0.1495 - acc:  
 0.9250 - val\_loss: 9.2015 - val\_acc: 0.5000  
 Epoch 246/300  
 5/5 [=====] - 4s 800ms/step - loss: 0.2813 - acc:  
 0.9500 - val\_loss: 17.7710 - val\_acc: 0.5000  
 Epoch 247/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.2709 - acc:  
 0.8750 - val\_loss: 9.7690 - val\_acc: 0.5500  
 Epoch 248/300  
 5/5 [=====] - 4s 794ms/step - loss: 0.1307 - acc:  
 0.9500 - val\_loss: 8.1055 - val\_acc: 0.6000  
 Epoch 249/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.1707 - acc:  
 0.9500 - val\_loss: 7.2566 - val\_acc: 0.6000  
 Epoch 250/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.1304 - acc:  
 0.9000 - val\_loss: 8.5095 - val\_acc: 0.5500  
 Epoch 251/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.1328 - acc:  
 0.9750 - val\_loss: 9.2060 - val\_acc: 0.6000  
 Epoch 252/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.1248 - acc:  
 0.9500 - val\_loss: 17.7495 - val\_acc: 0.6500  
 Epoch 253/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.2672 - acc:  
 0.8750 - val\_loss: 8.9259 - val\_acc: 0.5500  
 Epoch 254/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.4448 - acc:  
 0.8750 - val\_loss: 11.3265 - val\_acc: 0.6000  
 Epoch 255/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.1189 - acc:  
 0.9250 - val\_loss: 4.4974 - val\_acc: 0.6000  
 Epoch 256/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.4211 - acc:  
 0.9250 - val\_loss: 7.6195 - val\_acc: 0.3000  
 Epoch 257/300  
 5/5 [=====] - 4s 779ms/step - loss: 0.1708 - acc:  
 0.9250 - val\_loss: 7.8714 - val\_acc: 0.5000  
 Epoch 258/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.2750 - acc:  
 0.8250 - val\_loss: 14.1928 - val\_acc: 0.3000  
 Epoch 259/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.5502 - acc:  
 0.8250 - val\_loss: 9.6469 - val\_acc: 0.5000  
 Epoch 260/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.2488 - acc:  
 0.8000 - val\_loss: 2.9050 - val\_acc: 0.5500  
 Epoch 261/300



5/5 [=====] - 4s 796ms/step - loss: 0.2138 - acc:  
 0.9250 - val\_loss: 3.1841 - val\_acc: 0.5000  
 Epoch 262/300  
 5/5 [=====] - 4s 781ms/step - loss: 0.3633 - acc:  
 0.8250 - val\_loss: 3.2923 - val\_acc: 0.4000  
 Epoch 263/300  
 5/5 [=====] - 4s 795ms/step - loss: 0.2379 - acc:  
 0.8750 - val\_loss: 3.4262 - val\_acc: 0.5000  
 Epoch 264/300  
 5/5 [=====] - 4s 793ms/step - loss: 0.2159 - acc:  
 0.9000 - val\_loss: 1.0175 - val\_acc: 0.6000  
 Epoch 265/300  
 5/5 [=====] - 4s 797ms/step - loss: 0.2045 - acc:  
 0.9000 - val\_loss: 6.5660 - val\_acc: 0.5000  
 Epoch 266/300  
 5/5 [=====] - 4s 777ms/step - loss: 0.3790 - acc:  
 0.9250 - val\_loss: 4.9048 - val\_acc: 0.5500  
 Epoch 267/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.1373 - acc:  
 0.9500 - val\_loss: 5.4590 - val\_acc: 0.5500  
 Epoch 268/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.3199 - acc:  
 0.9000 - val\_loss: 6.7928 - val\_acc: 0.5000  
 Epoch 269/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.2105 - acc:  
 0.9500 - val\_loss: 6.8908 - val\_acc: 0.6000  
 Epoch 270/300  
 5/5 [=====] - 4s 782ms/step - loss: 0.2226 - acc:  
 0.8250 - val\_loss: 14.0388 - val\_acc: 0.5000  
 Epoch 271/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.0957 - acc:  
 0.9750 - val\_loss: 8.1135 - val\_acc: 0.5500  
 Epoch 272/300  
 5/5 [=====] - 4s 800ms/step - loss: 0.5563 - acc:  
 0.9500 - val\_loss: 4.5444 - val\_acc: 0.6000  
 Epoch 273/300  
 5/5 [=====] - 4s 780ms/step - loss: 0.2602 - acc:  
 0.9500 - val\_loss: 2.8715 - val\_acc: 0.5500  
 Epoch 274/300  
 5/5 [=====] - 4s 783ms/step - loss: 0.1181 - acc:  
 0.9500 - val\_loss: 1.7318 - val\_acc: 0.5500  
 Epoch 275/300  
 5/5 [=====] - 4s 793ms/step - loss: 0.1301 - acc:  
 0.9750 - val\_loss: 1.8740 - val\_acc: 0.5500  
 Epoch 276/300  
 5/5 [=====] - 4s 794ms/step - loss: 0.2694 - acc:  
 0.8500 - val\_loss: 1.4535 - val\_acc: 0.7000  
 Epoch 277/300

5/5 [=====] - 4s 776ms/step - loss: 0.1437 - acc:  
0.9750 - val\_loss: 1.0620 - val\_acc: 0.6500  
Epoch 278/300  
5/5 [=====] - 4s 781ms/step - loss: 0.4983 - acc:  
0.9500 - val\_loss: 1.2964 - val\_acc: 0.6500  
Epoch 279/300  
5/5 [=====] - 4s 796ms/step - loss: 0.1387 - acc:  
0.9750 - val\_loss: 1.6211 - val\_acc: 0.6000  
Epoch 280/300  
5/5 [=====] - 4s 795ms/step - loss: 0.1652 - acc:  
0.9500 - val\_loss: 1.8450 - val\_acc: 0.5500  
Epoch 281/300  
5/5 [=====] - 4s 794ms/step - loss: 0.1568 - acc:  
0.9500 - val\_loss: 3.2402 - val\_acc: 0.5500  
Epoch 282/300  
5/5 [=====] - 4s 780ms/step - loss: 0.1379 - acc:  
0.9500 - val\_loss: 2.6528 - val\_acc: 0.6500  
Epoch 283/300  
5/5 [=====] - 4s 779ms/step - loss: 0.0951 - acc:  
0.9750 - val\_loss: 1.6424 - val\_acc: 0.7000  
Epoch 284/300  
5/5 [=====] - 4s 779ms/step - loss: 0.0961 - acc:  
0.9500 - val\_loss: 2.4464 - val\_acc: 0.5500  
Epoch 285/300  
5/5 [=====] - 4s 779ms/step - loss: 0.1854 - acc:  
0.9250 - val\_loss: 2.8493 - val\_acc: 0.6500  
Epoch 286/300  
5/5 [=====] - 4s 779ms/step - loss: 0.1336 - acc:  
0.9500 - val\_loss: 5.4866 - val\_acc: 0.7000  
Epoch 287/300  
5/5 [=====] - 4s 779ms/step - loss: 0.0784 - acc:  
0.9750 - val\_loss: 6.3323 - val\_acc: 0.6000  
Epoch 288/300  
5/5 [=====] - 4s 781ms/step - loss: 0.2047 - acc:  
0.8750 - val\_loss: 7.1462 - val\_acc: 0.5000  
Epoch 289/300  
5/5 [=====] - 4s 780ms/step - loss: 0.1549 - acc:  
0.9500 - val\_loss: 4.0907 - val\_acc: 0.5500  
Epoch 290/300  
5/5 [=====] - 4s 778ms/step - loss: 0.1052 - acc:  
0.9500 - val\_loss: 2.3547 - val\_acc: 0.7000  
Epoch 291/300  
5/5 [=====] - 4s 781ms/step - loss: 0.2128 - acc:  
0.9000 - val\_loss: 1.6837 - val\_acc: 0.6500  
Epoch 292/300  
5/5 [=====] - 4s 779ms/step - loss: 0.1619 - acc:  
0.9000 - val\_loss: 2.3869 - val\_acc: 0.5000  
Epoch 293/300

```

5/5 [=====] - 4s 793ms/step - loss: 0.1624 - acc:
0.9000 - val_loss: 2.3433 - val_acc: 0.5500
Epoch 294/300
5/5 [=====] - 4s 777ms/step - loss: 0.1605 - acc:
0.9500 - val_loss: 3.3836 - val_acc: 0.4500
Epoch 295/300
5/5 [=====] - 4s 779ms/step - loss: 0.1180 - acc:
0.9500 - val_loss: 2.6180 - val_acc: 0.5500
Epoch 296/300
5/5 [=====] - 4s 780ms/step - loss: 0.2304 - acc:
0.9000 - val_loss: 3.7257 - val_acc: 0.5000
Epoch 297/300
5/5 [=====] - 4s 793ms/step - loss: 0.1458 - acc:
0.9500 - val_loss: 2.4329 - val_acc: 0.5500
Epoch 298/300
5/5 [=====] - 4s 812ms/step - loss: 0.0797 - acc:
0.9500 - val_loss: 2.8619 - val_acc: 0.6500
Epoch 299/300
5/5 [=====] - 4s 794ms/step - loss: 0.2097 - acc:
0.9250 - val_loss: 3.0915 - val_acc: 0.5500
Epoch 300/300
5/5 [=====] - 4s 794ms/step - loss: 0.1590 - acc:
0.9500 - val_loss: 1.4969 - val_acc: 0.6500

```

```

[48]: acc = history.history['acc']
      val_acc = history.history['val_acc']

      loss = history.history['loss']
      val_loss = history.history['val_loss']

      epochs = range(len(acc))

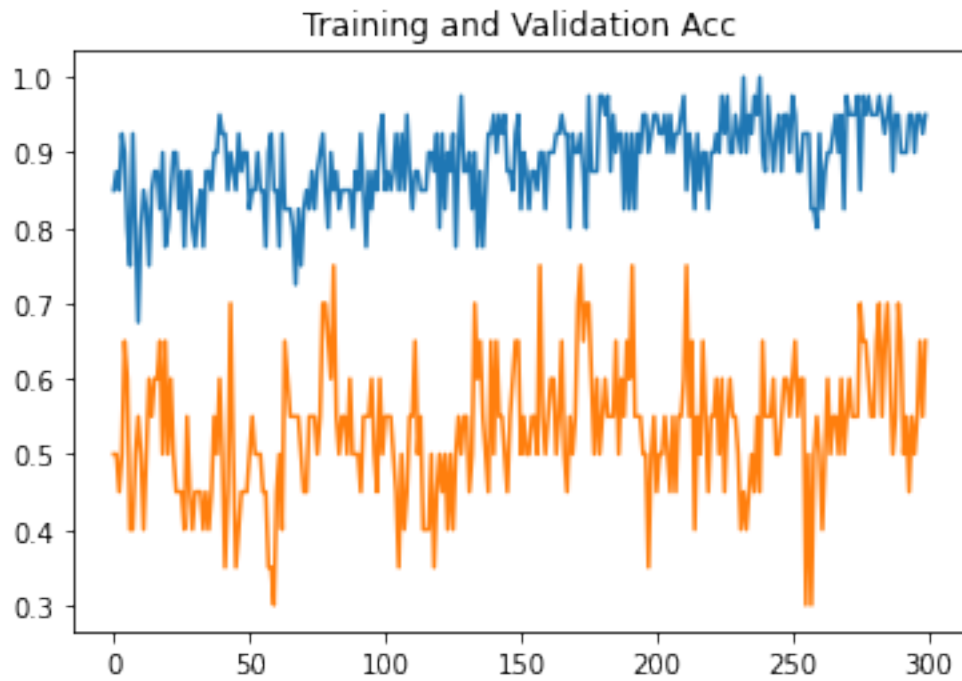
      plt.plot(epochs, acc)
      plt.plot(epochs, val_acc)
      plt.title('Training and Validation Acc')

```

```

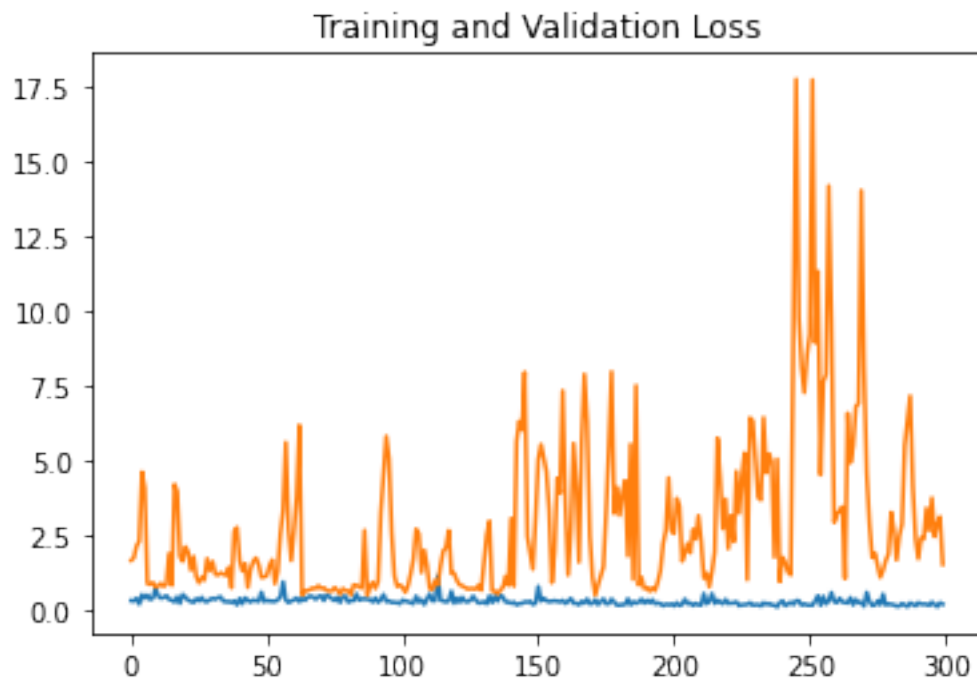
[48]: Text(0.5, 1.0, 'Training and Validation Acc')

```



```
[49]: plt.plot(epochs, loss)
      plt.plot(epochs, val_loss)
      plt.title('Training and Validation Loss')
```

```
[49]: Text(0.5, 1.0, 'Training and Validation Loss')
```



```
[50]: _, acc = model.evaluate_generator(test_data, steps=test_data.n, verbose=0)
      print('> %.3f' % (acc * 100.0))
```

> 60.000

```
[ ]:
```