In [ ]:

```
import matplotlib.pyplot as plt
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Flatten, Dense, Conv2D, MaxPooling2D,
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.utils import plot_model

# Функция для загрузки и аугментации данных
def prepare_data(train_dir, test_dir, img_size=(150, 150), batch_size=32)
    train_datagen = ImageDataGenerator(
        rescale=1./255,
        rotation_range=40,
        width_shift_range=0.2,
        height_shift_range=0.2,
        shear_range=0.2,
        zoom_range=0.2,
        horizontal_flip=True,
        fill_mode='nearest')

    test_datagen = ImageDataGenerator(rescale=1./255)

    train_generator = train_datagen.flow_from_directory(
        train_dir,
        target_size=img_size,
        batch_size=batch_size,
        class_mode='binary')

    test_generator = test_datagen.flow_from_directory(
        test_dir,
        target_size=img_size,
        batch_size=batch_size,
        class_mode='binary')

    return train_generator, test_generator

# Улучшенная полносвязная нейронная сеть
def improved_fcc_nn(input_shape):
    model = Sequential([
        Flatten(input_shape=input_shape),
        Dense(1024, activation='relu'),
        Dropout(0.5),
        Dense(512, activation='relu'),
        Dropout(0.5),
        Dense(256, activation='relu'),
        Dropout(0.5),
        Dense(1, activation='sigmoid')
    ])

    model.compile(optimizer='adam',
                  loss='binary_crossentropy',
                  metrics=['accuracy'])
    return model

# Улучшенная сверточная нейронная сеть
def improved_conv_nn(input_shape):
    model = Sequential([
```

```
        Conv2D(32, (3, 3), activation='relu', input_shape=input_shape),
        MaxPooling2D(2, 2),
        Conv2D(64, (3, 3), activation='relu'),
        MaxPooling2D(2, 2),
        Conv2D(128, (3, 3), activation='relu'),
        MaxPooling2D(2, 2),
        Flatten(),
        Dense(1024, activation='relu'),
        Dropout(0.5),
        Dense(512, activation='relu'),
        Dropout(0.5),
        Dense(256, activation='relu'),
        Dropout(0.5),
        Dense(1, activation='sigmoid')
    ])

    model.compile(optimizer='adam',
                  loss='binary_crossentropy',
                  metrics=['accuracy'])
    return model

# Функция для обучения модели
def train_model(model, train_data, test_data, epochs=50):
    history = model.fit(
        train_data,
        validation_data=test_data,
        epochs=epochs
    )
    return history

# Функция для визуализации результатов обучения
def plot_history(history):
    acc = history.history['accuracy']
    val_acc = history.history['val_accuracy']
    loss = history.history['loss']
    val_loss = history.history['val_loss']

    epochs = range(len(acc))

    plt.plot(epochs, acc, 'bo', label='Training acc')
    plt.plot(epochs, val_acc, 'b', label='Validation acc')
    plt.title('Training and validation accuracy')
    plt.legend()

    plt.figure()

    plt.plot(epochs, loss, 'bo', label='Training loss')
    plt.plot(epochs, val_loss, 'b', label='Validation loss')
    plt.title('Training and validation loss')
    plt.legend()

    plt.show()

# Визуализация парсептрона
def plot_model_pars(model):
    plot_model(model, to_file='model_pars.png', show_shapes=True, show_la
```

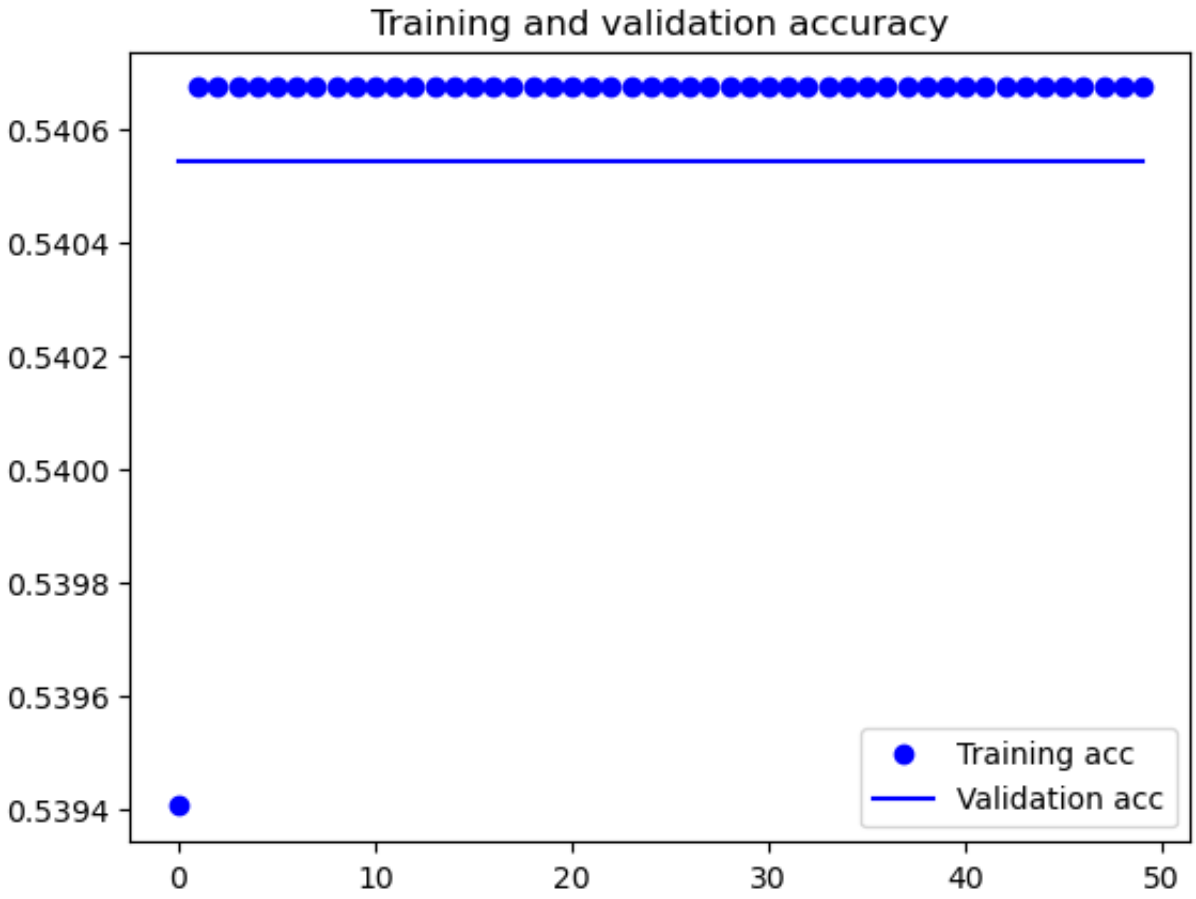
```
# Подготовка данных
train_data, test_data = prepare_data('./train', './test')

# Обучение улучшенной полносвязной модели
improved_fcc_model = improved_fcc_nn(input_shape=(150, 150, 3))
improved_fcc_history = train_model(improved_fcc_model, train_data, test_d
print("Обучение улучшенной полносвязной модели завершено.")
plot_history(improved_fcc_history)
plot_model_pars(improved_fcc_model)

# Обучение улучшенной сверточной модели
improved_conv_model = improved_conv_nn(input_shape=(150, 150, 3))
improved_conv_history = train_model(improved_conv_model, train_data, test
print("Обучение улучшенной сверточной модели завершено.")
plot_history(improved_conv_history)
plot_model_pars(improved_conv_model)

# Вывод
# После обучения обеих моделей,```
```

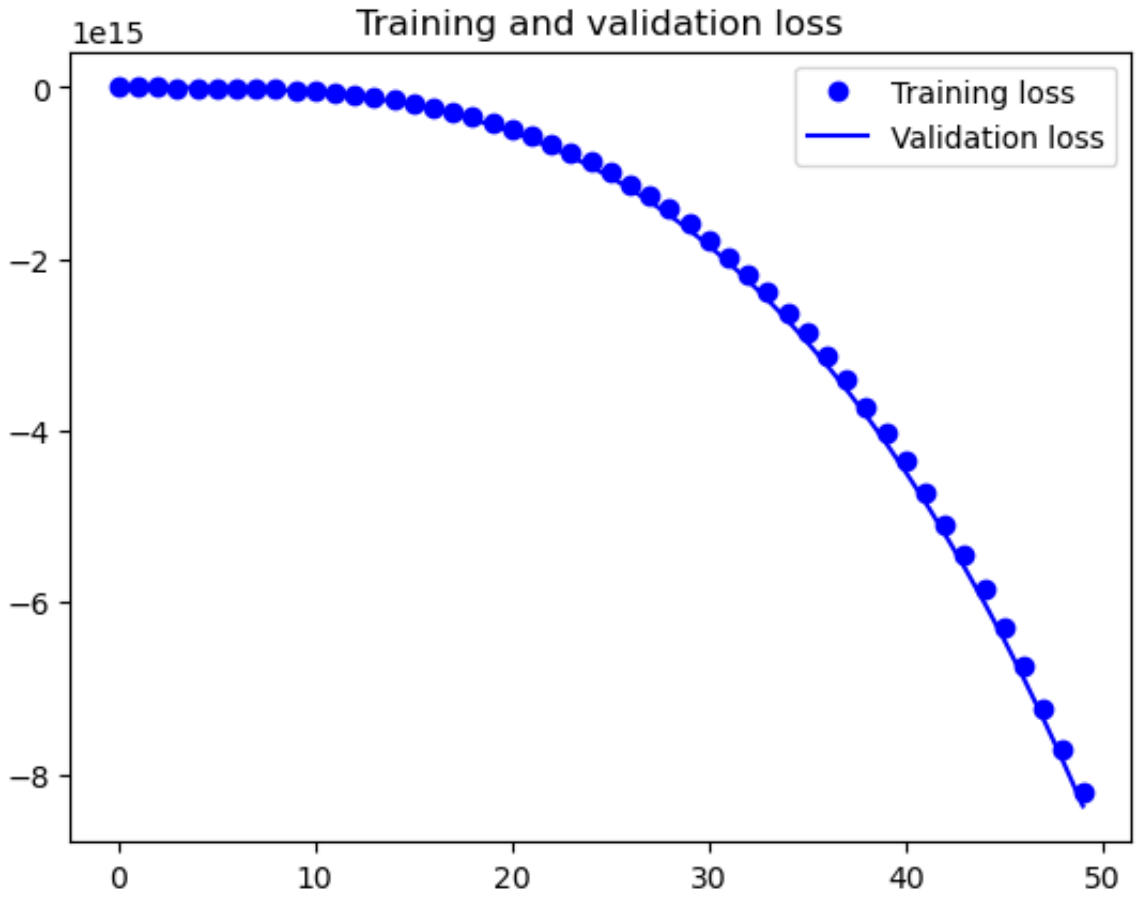
```
Found 4733 images belonging to 3 classes.
Found 1184 images belonging to 3 classes.
Epoch 1/50
148/148 [==============================] - 50s 331ms/step - loss: -2977506
88.0000 - accuracy: 0.5394 - val_loss: -1764272896.0000 - val_accuracy: 0.
5405
Epoch 2/50
148/148 [==============================] - 49s 332ms/step - loss: -1734529
6384.0000 - accuracy: 0.5407 - val_loss: -49901158400.0000 - val_accuracy:
0.5405
Epoch 3/50
148/148 [==============================] - 49s 329ms/step - loss: -1527922
52416.0000 - accuracy: 0.5407 - val_loss: -308444954624.0000 - val_accurac
y: 0.5405
Epoch 4/50
148/148 [==============================] - 49s 331ms/step - loss: -6355405
37344.0000 - accuracy: 0.5407 - val_loss: -1062018744320.0000 - val_accura
cy: 0.5405
Epoch 5/50
148/148 [==============================] - 49s 328ms/step - loss: -1781932
752896.0000 - accuracy: 0.5407 - val_loss: -2647316234240.0000 - val_accur
acy: 0.5405
Epoch 6/50
148/148 [==============================] - 48s 323ms/step - loss: -3972392
288256.0000 - accuracy: 0.5407 - val_loss: -5500422324224.0000 - val_accur
acy: 0.5405
Epoch 7/50
148/148 [==============================] - 49s 329ms/step - loss: -7670722
461696.0000 - accuracy: 0.5407 - val_loss: -10058559651840.0000 - val_accu
racy: 0.5405
Epoch 8/50
148/148 [==============================] - 49s 328ms/step - loss: -1329409
0846208.0000 - accuracy: 0.5407 - val_loss: -16817521164288.0000 - val_acc
uracy: 0.5405
Epoch 9/50
148/148 [==============================] - 48s 326ms/step - loss: -2148159
7698048.0000 - accuracy: 0.5407 - val_loss: -26181963350016.0000 - val_acc
```

```
uracy: 0.5405
Epoch 10/50
148/148 [==============================] - 49s 327ms/step - loss: -3260027
3977344.0000 - accuracy: 0.5407 - val_loss: -38818719727616.0000 - val_acc
uracy: 0.5405
Epoch 11/50
148/148 [==============================] - 50s 337ms/step - loss: -4704317
5251968.0000 - accuracy: 0.5407 - val_loss: -54951304757248.0000 - val_acc
uracy: 0.5405
Epoch 12/50
148/148 [==============================] - 49s 331ms/step - loss: -6500466
9763584.0000 - accuracy: 0.5407 - val_loss: -75139437821952.0000 - val_acc
uracy: 0.5405
Epoch 13/50
148/148 [==============================] - 48s 321ms/step - loss: -8789003
8095872.0000 - accuracy: 0.5407 - val_loss: -100088416305152.0000 - val_ac
curacy: 0.5405
Epoch 14/50
148/148 [==============================] - 47s 315ms/step - loss: -1158794
25605632.0000 - accuracy: 0.5407 - val_loss: -130073545932800.0000 - val_a
ccuracy: 0.5405
Epoch 15/50
148/148 [==============================] - 49s 328ms/step - loss: -1494465
57958144.0000 - accuracy: 0.5407 - val_loss: -165752082530304.0000 - val_a
ccuracy: 0.5405
Epoch 16/50
148/148 [==============================] - 49s 327ms/step - loss: -1872652
71726080.0000 - accuracy: 0.5407 - val_loss: -207367983595520.0000 - val_a
ccuracy: 0.5405
Epoch 17/50
148/148 [==============================] - 50s 334ms/step - loss: -2326972
68011008.0000 - accuracy: 0.5407 - val_loss: -255291933327360.0000 - val_a
ccuracy: 0.5405
Epoch 18/50
148/148 [==============================] - 48s 324ms/step - loss: -2839722
31757824.0000 - accuracy: 0.5407 - val_loss: -309799178731520.0000 - val_a
ccuracy: 0.5405
Epoch 19/50
148/148 [==============================] - 48s 326ms/step - loss: -3426246
40696320.0000 - accuracy: 0.5407 - val_loss: -371915344576512.0000 - val_a
ccuracy: 0.5405
Epoch 20/50
148/148 [==============================] - 48s 325ms/step - loss: -4094010
13829632.0000 - accuracy: 0.5407 - val_loss: -441521866276864.0000 - val_a
ccuracy: 0.5405
Epoch 21/50
148/148 [==============================] - 48s 321ms/step - loss: -4820041
81188608.0000 - accuracy: 0.5407 - val_loss: -518870603399168.0000 - val_a
ccuracy: 0.5405
Epoch 22/50
148/148 [==============================] - 49s 328ms/step - loss: -5675626
81188352.0000 - accuracy: 0.5407 - val_loss: -605717828468736.0000 - val_a
ccuracy: 0.5405
Epoch 23/50
148/148 [==============================] - 50s 337ms/step - loss: -6596298
01472000.0000 - accuracy: 0.5407 - val_loss: -701323666259968.0000 - val_a
ccuracy: 0.5405
```

```
Epoch 24/50
148/148 [==============================] - 49s 331ms/step - loss: -7607366
87063040.0000 - accuracy: 0.5407 - val_loss: -806172877651968.0000 - val_a
ccuracy: 0.5405
Epoch 25/50
148/148 [==============================] - 48s 324ms/step - loss: -8696947
72871168.0000 - accuracy: 0.5407 - val_loss: -920935880196096.0000 - val_a
ccuracy: 0.5405
Epoch 26/50
148/148 [==============================] - 48s 324ms/step - loss: -9926176
09297920.0000 - accuracy: 0.5407 - val_loss: -1046447105507328.0000 - val_
accuracy: 0.5405
Epoch 27/50
148/148 [==============================] - 49s 327ms/step - loss: -1123565
927661568.0000 - accuracy: 0.5407 - val_loss: -1182403154411520.0000 - val
_accuracy: 0.5405
Epoch 28/50
148/148 [==============================] - 48s 324ms/step - loss: -1264087
661019136.0000 - accuracy: 0.5407 - val_loss: -1329494375792640.0000 - val
_accuracy: 0.5405
Epoch 29/50
148/148 [==============================] - 49s 332ms/step - loss: -1418789
564448768.0000 - accuracy: 0.5407 - val_loss: -1488229387730944.0000 - val
_accuracy: 0.5405
Epoch 30/50
148/148 [==============================] - 50s 334ms/step - loss: -1586253
023674368.0000 - accuracy: 0.5407 - val_loss: -1659165999104000.0000 - val
_accuracy: 0.5405
Epoch 31/50
148/148 [==============================] - 48s 324ms/step - loss: -1771483
420426240.0000 - accuracy: 0.5407 - val_loss: -1843529617768448.0000 - val
_accuracy: 0.5405
Epoch 32/50
148/148 [==============================] - 49s 327ms/step - loss: -1971133
767221248.0000 - accuracy: 0.5407 - val_loss: -2040343675535360.0000 - val
_accuracy: 0.5405
Epoch 33/50
148/148 [==============================] - 49s 327ms/step - loss: -2171634
249105408.0000 - accuracy: 0.5407 - val_loss: -2251433667723264.0000 - val
_accuracy: 0.5405
Epoch 34/50
148/148 [==============================] - 48s 324ms/step - loss: -2384746
499801088.0000 - accuracy: 0.5407 - val_loss: -2475218643714048.0000 - val
_accuracy: 0.5405
Epoch 35/50
148/148 [==============================] - 49s 330ms/step - loss: -2623832
565219328.0000 - accuracy: 0.5407 - val_loss: -2714239210881024.0000 - val
_accuracy: 0.5405
Epoch 36/50
148/148 [==============================] - 49s 329ms/step - loss: -2864772
982767616.0000 - accuracy: 0.5407 - val_loss: -2967048770551808.0000 - val
_accuracy: 0.5405
Epoch 37/50
148/148 [==============================] - 48s 322ms/step - loss: -3128808
781643776.0000 - accuracy: 0.5407 - val_loss: -3236102433406976.0000 - val
_accuracy: 0.5405
Epoch 38/50
```

```
148/148 [==============================] - 48s 323ms/step - loss: -3400541
161914368.0000 - accuracy: 0.5407 - val_loss: -3520309009317888.0000 - val
_accuracy: 0.5405
Epoch 39/50
148/148 [==============================] - 48s 324ms/step - loss: -3716758
129082368.0000 - accuracy: 0.5407 - val_loss: -3823247011348480.0000 - val
_accuracy: 0.5405
Epoch 40/50
148/148 [==============================] - 48s 325ms/step - loss: -4030740
371079168.0000 - accuracy: 0.5407 - val_loss: -4141544621735936.0000 - val
_accuracy: 0.5405
Epoch 41/50
148/148 [==============================] - 49s 330ms/step - loss: -4359537
297457152.0000 - accuracy: 0.5407 - val_loss: -4479551568609280.0000 - val
_accuracy: 0.5405
Epoch 42/50
148/148 [==============================] - 49s 329ms/step - loss: -4717861
050253312.0000 - accuracy: 0.5407 - val_loss: -4832064767524864.0000 - val
_accuracy: 0.5405
Epoch 43/50
148/148 [==============================] - 48s 325ms/step - loss: -5091938
206220288.0000 - accuracy: 0.5407 - val_loss: -5206298152927232.0000 - val
_accuracy: 0.5405
Epoch 44/50
148/148 [==============================] - 48s 325ms/step - loss: -5454847
910346752.0000 - accuracy: 0.5407 - val_loss: -5596244676182016.0000 - val
_accuracy: 0.5405
Epoch 45/50
148/148 [==============================] - 48s 320ms/step - loss: -5851074
212659200.0000 - accuracy: 0.5407 - val_loss: -6003814523994112.0000 - val
_accuracy: 0.5405
Epoch 46/50
148/148 [==============================] - 48s 325ms/step - loss: -6285319
565475840.0000 - accuracy: 0.5407 - val_loss: -6434061262258176.0000 - val
_accuracy: 0.5405
Epoch 47/50
148/148 [==============================] - 48s 322ms/step - loss: -6739309
956694016.0000 - accuracy: 0.5407 - val_loss: -6886265483952128.0000 - val
_accuracy: 0.5405
Epoch 48/50
148/148 [==============================] - 49s 332ms/step - loss: -7228234
001285120.0000 - accuracy: 0.5407 - val_loss: -7358616860360704.0000 - val
_accuracy: 0.5405
Epoch 49/50
148/148 [==============================] - 50s 335ms/step - loss: -7704103
492780032.0000 - accuracy: 0.5407 - val_loss: -7853012693286912.0000 - val
_accuracy: 0.5405
Epoch 50/50
148/148 [==============================] - 49s 327ms/step - loss: -8212546
016247808.0000 - accuracy: 0.5407 - val_loss: -8370825224781824.0000 - val
_accuracy: 0.5405
Обучение улучшенной полносвязной модели завершено.
```






```
You must install pydot (`pip install pydot`) and install graphviz (see ins
tructions at https://graphviz.gitlab.io/download/) for plot_model to work.
Epoch 1/50
148/148 [==============================] - 54s 354ms/step - loss: -6012040
380416.0000 - accuracy: 0.5377 - val_loss: -65721895747584.0000 - val_accu
racy: 0.5405
```

```
Epoch 2/50
148/148 [==============================] - 52s 350ms/step - loss: -9401556
709408768.0000 - accuracy: 0.5407 - val_loss: -49060256076005376.0000 - va
l_accuracy: 0.5405
Epoch 3/50
148/148 [==============================] - 52s 349ms/step - loss: -5205911
99241764864.0000 - accuracy: 0.5407 - val_loss: -17028595625471508 48.0000
- val_accuracy: 0.5405
Epoch 4/50
148/148 [==============================] - 52s 347ms/step - loss: -7264894
437669470208.0000 - accuracy: 0.5407 - val_loss: -176797456528939417 60.000
0 - val_accuracy: 0.5405
Epoch 5/50
148/148 [==============================] - 52s 347ms/step - loss: -4807003
7037901676544.0000 - accuracy: 0.5407 - val_loss: -984901086563606200 32.00
00 - val_accuracy: 0.5405
Epoch 6/50
148/148 [==============================] - 52s 349ms/step - loss: -2131692
68190420664320.0000 - accuracy: 0.5407 - val_loss: -382861700371880869888.
0000 - val_accuracy: 0.5405
Epoch 7/50
148/148 [==============================] - 51s 346ms/step - loss: -7067816
25826876063744.0000 - accuracy: 0.5407 - val_loss: -115069929596657163468 8
0.0000 - val_accuracy: 0.5405
Epoch 8/50
148/148 [==============================] - 52s 349ms/step - loss: -1910914
476590227259392.0000 - accuracy: 0.5407 - val_loss: -2911672016162177155072
.0000 - val_accuracy: 0.5405
Epoch 9/50
148/148 [==============================] - 52s 347ms/step - loss: nan - ac
curacy: 0.1566 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 10/50
148/148 [==============================] - 52s 352ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 11/50
148/148 [==============================] - 52s 350ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 12/50
148/148 [==============================] - 52s 348ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 13/50
148/148 [==============================] - 51s 343ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 14/50
148/148 [==============================] - 52s 349ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 15/50
148/148 [==============================] - 51s 346ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 16/50
148/148 [==============================] - 52s 348ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 17/50
148/148 [==============================] - 52s 353ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 18/50
148/148 [==============================] - 52s 353ms/step - loss: nan - ac
```

```
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 19/50
148/148 [==============================] - 52s 350ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 20/50
148/148 [==============================] - 53s 354ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 21/50
148/148 [==============================] - 52s 348ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 22/50
148/148 [==============================] - 52s 352ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 23/50
148/148 [==============================] - 52s 349ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 24/50
148/148 [==============================] - 52s 351ms/step - loss: nan - ac
curacy: 0.0000e+00 - val_loss: nan - val_accuracy: 0.0000e+00
Epoch 25/50
 43/148 [=======>......................] - ETA: 33s - loss: nan - accurac
y: 0.0000e+00
```

In [ ]: