In [3]:

```python
import numpy as np
import tensorflow as tough
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense, Dropout, BatchNormalization
from tensorflow.keras.optimizers import Adam
from sklearn.model_selection import train_test_split
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from skimage.transform import resize
from tensorflow.keras.regularizers import l2

def loadingData():
    data_full = np.load('data_train.npy')
    labels_all = np.load('labels_train.npy')

    #Reshape and Resize data
    reshaped_data = data.T.reshape((-1, 300, 300, 3))
    resizing_data = np.array([resize(img, (100, 100, 3), anti_aliasing=True) for img in reshaped_data])

    # Preprocessing the data
    normalizingData = resizing_data / 255.0

    return normalizingData, labels_all

def building_model():
    model = Sequential([
        Conv2D(64, (3, 3), activation='relu', input_shape=(100, 100, 3)),
        BatchNormalization(),
        MaxPooling2D((2, 2)),

        Conv2D(128, (3, 3), activation='relu'),
        BatchNormalization(),
        MaxPooling2D((2, 2)),

        Conv2D(256, (3, 3), activation='relu'),
        BatchNormalization(),
        MaxPooling2D((2, 2)),

        Conv2D(512, (3, 3), activation='relu'),
        BatchNormalization(),
        MaxPooling2D((2, 2)),

        #Increasing Complexity of the model and adjusting dropout rate with more Dense
        Flatten(),
        Dense(1024, activation='relu', kernel_regularizer=l2(0.001)),
        Dropout(0.4),
        Dense(512, activation='relu', kernel_regularizer=l2(0.001)),
        Dropout(0.3),
        Dense(9, activation='softmax')
    ])

    return model

def trainingSet():
    data_full, labels_all = loadingData()

    # Using Data augmentation generator and increasing it.
    datagen = ImageDataGenerator(
        rotation_range=20,
        width_shift_range=0.15,
        height_shift_range=0.15,
        zoom_range=0.2,
        horizontal_flip=True,
        fill_mode='nearest'
    )

    # Splitting the data into 80% of Training data and 20% Testing data.
    train_data, val_data, train_labels, val_labels = train_test_split(data_full, labels_all, test_size=0.2, random_state=42)


    model = building_model()
    model.compile(optimizer=Adam(learning_rate=0.0003), loss='sparse_categorical_crossentropy', metrics=['accuracy'])

    # Callbacks which keeps an eye on validation_loss:
    earlyStopping = tough.keras.callbacks.EarlyStopping(monitor='val_loss', patience=15)
    learningRate_scheduler = tough.keras.callbacks.ReduceLROnPlateau(monitor='val_loss', factor=0.1, patience=7, min_lr=0.00001)
    modellingCheckpoint = tough.keras.callbacks.ModelCheckpoint('my_best_model.h5', save_best_only=True)

    # Training the model with the parameters given in the callbacks functions.
    trainingGenerator = datagen.flow(train_data, train_labels, batch_size=32)
    model.fit(trainingGenerator, epochs=60, validation_data=(val_data, val_labels),
              callbacks=[earlyStopping, learningRate_scheduler, modellingCheckpoint])


if __name__ == "__main__":
    trainingSet()
```

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Epoch 1/60
212/212 [==============================] - 12s 52ms/step - loss: 5.2616 - accuracy: 0.1220 - val_loss: 6.0595 - val_accuracy: 0.
1113 - lr: 3.0000e-04
Epoch 2/60
212/212 [==============================] - 11s 50ms/step - loss: 4.6421 - accuracy: 0.1334 - val_loss: 4.8237 - val_accuracy: 0.
1113 - lr: 3.0000e-04
Epoch 3/60
212/212 [==============================] - 11s 50ms/step - loss: 4.3487 - accuracy: 0.1516 - val_loss: 4.1800 - val_accuracy: 0.
1551 - lr: 3.0000e-04
Epoch 4/60
212/212 [==============================] - 11s 50ms/step - loss: 4.0602 - accuracy: 0.1697 - val_loss: 3.8687 - val_accuracy: 0.
2362 - lr: 3.0000e-04
Epoch 5/60
212/212 [==============================] - 11s 50ms/step - loss: 3.7566 - accuracy: 0.2039 - val_loss: 3.7514 - val_accuracy: 0.
1652 - lr: 3.0000e-04
Epoch 6/60
212/212 [==============================] - 11s 50ms/step - loss: 3.4658 - accuracy: 0.2431 - val_loss: 3.3578 - val_accuracy: 0.
2410 - lr: 3.0000e-04
Epoch 7/60
212/212 [==============================] - 11s 50ms/step - loss: 3.1677 - accuracy: 0.2936 - val_loss: 3.0798 - val_accuracy: 0.
3102 - lr: 3.0000e-04
Epoch 8/60
212/212 [==============================] - 11s 50ms/step - loss: 2.8778 - accuracy: 0.3413 - val_loss: 2.9942 - val_accuracy: 0.
2747 - lr: 3.0000e-04
Epoch 9/60
212/212 [==============================] - 11s 51ms/step - loss: 2.6133 - accuracy: 0.4058 - val_loss: 2.3408 - val_accuracy: 0.
5145 - lr: 3.0000e-04
Epoch 10/60
212/212 [==============================] - 11s 50ms/step - loss: 2.3825 - accuracy: 0.4563 - val_loss: 2.2402 - val_accuracy: 0.
5631 - lr: 3.0000e-04
Epoch 11/60
212/212 [==============================] - 11s 50ms/step - loss: 2.1965 - accuracy: 0.5102 - val_loss: 2.0304 - val_accuracy: 0.
5583 - lr: 3.0000e-04
Epoch 12/60
212/212 [==============================] - 11s 51ms/step - loss: 2.0270 - accuracy: 0.5548 - val_loss: 1.8586 - val_accuracy: 0.
6264 - lr: 3.0000e-04
Epoch 13/60
212/212 [==============================] - 11s 50ms/step - loss: 1.9823 - accuracy: 0.5791 - val_loss: 1.8519 - val_accuracy: 0.
6128 - lr: 3.0000e-04
Epoch 14/60
212/212 [==============================] - 11s 50ms/step - loss: 1.8481 - accuracy: 0.6183 - val_loss: 1.8244 - val_accuracy: 0.
6507 - lr: 3.0000e-04
Epoch 15/60
212/212 [==============================] - 11s 50ms/step - loss: 1.7489 - accuracy: 0.6515 - val_loss: 1.7540 - val_accuracy: 0.
6696 - lr: 3.0000e-04
Epoch 16/60
212/212 [==============================] - 10s 49ms/step - loss: 1.6674 - accuracy: 0.6846 - val_loss: 1.7666 - val_accuracy: 0.
6459 - lr: 3.0000e-04
Epoch 17/60
212/212 [==============================] - 11s 50ms/step - loss: 1.6143 - accuracy: 0.6980 - val_loss: 1.5134 - val_accuracy: 0.
7217 - lr: 3.0000e-04
Epoch 18/60
212/212 [==============================] - 10s 49ms/step - loss: 1.5818 - accuracy: 0.7154 - val_loss: 1.5670 - val_accuracy: 0.
7294 - lr: 3.0000e-04
Epoch 19/60
212/212 [==============================] - 11s 50ms/step - loss: 1.5035 - accuracy: 0.7384 - val_loss: 1.3460 - val_accuracy: 0.
8046 - lr: 3.0000e-04
Epoch 20/60
212/212 [==============================] - 11s 51ms/step - loss: 1.4508 - accuracy: 0.7572 - val_loss: 1.3157 - val_accuracy: 0.
8022 - lr: 3.0000e-04
Epoch 21/60
212/212 [==============================] - 10s 49ms/step - loss: 1.4308 - accuracy: 0.7640 - val_loss: 1.6047 - val_accuracy: 0.
7235 - lr: 3.0000e-04
Epoch 22/60
212/212 [==============================] - 10s 49ms/step - loss: 1.3760 - accuracy: 0.7760 - val_loss: 1.3597 - val_accuracy: 0.
7993 - lr: 3.0000e-04
Epoch 23/60
212/212 [==============================] - 11s 50ms/step - loss: 1.3248 - accuracy: 0.7936 - val_loss: 1.2839 - val_accuracy: 0.
8058 - lr: 3.0000e-04
Epoch 24/60
212/212 [==============================] - 10s 49ms/step - loss: 1.3269 - accuracy: 0.7948 - val_loss: 1.8637 - val_accuracy: 0.
5986 - lr: 3.0000e-04
Epoch 25/60
212/212 [==============================] - 10s 49ms/step - loss: 1.3179 - accuracy: 0.8016 - val_loss: 1.4266 - val_accuracy: 0.
7880 - lr: 3.0000e-04
Epoch 26/60
212/212 [==============================] - 10s 49ms/step - loss: 1.2873 - accuracy: 0.8035 - val_loss: 1.6391 - val_accuracy: 0.
6951 - lr: 3.0000e-04
Epoch 27/60
212/212 [==============================] - 11s 50ms/step - loss: 1.2651 - accuracy: 0.8117 - val_loss: 1.1491 - val_accuracy: 0.
8632 - lr: 3.0000e-04
Epoch 28/60
212/212 [==============================] - 10s 49ms/step - loss: 1.2296 - accuracy: 0.8244 - val_loss: 1.1802 - val_accuracy: 0.
8289 - lr: 3.0000e-04
Epoch 29/60
212/212 [==============================] - 11s 50ms/step - loss: 1.2015 - accuracy: 0.8333 - val_loss: 1.0767 - val_accuracy: 0.
8727 - lr: 3.0000e-04
Epoch 30/60
212/212 [==============================] - 10s 49ms/step - loss: 1.1904 - accuracy: 0.8297 - val_loss: 1.1349 - val_accuracy: 0.
8514 - lr: 3.0000e-04
Epoch 31/60
212/212 [==============================] - 10s 49ms/step - loss: 1.1263 - accuracy: 0.8519 - val_loss: 1.3298 - val_accuracy: 0.
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7809 - lr: 3.0000e-04
Epoch 32/60
212/212 [==============================] - 11s 50ms/step - loss: 1.1517 - accuracy: 0.8342 - val_loss: 1.1861 - val_accuracy: 0.
8336 - lr: 3.0000e-04
Epoch 33/60
212/212 [==============================] - 10s 49ms/step - loss: 1.1115 - accuracy: 0.8496 - val_loss: 1.1264 - val_accuracy: 0.
8425 - lr: 3.0000e-04
Epoch 34/60
212/212 [==============================] - 10s 49ms/step - loss: 1.0904 - accuracy: 0.8580 - val_loss: 1.1147 - val_accuracy: 0.
8455 - lr: 3.0000e-04
Epoch 35/60
212/212 [==============================] - 11s 50ms/step - loss: 1.0683 - accuracy: 0.8592 - val_loss: 1.0236 - val_accuracy: 0.
8769 - lr: 3.0000e-04
Epoch 36/60
212/212 [==============================] - 10s 49ms/step - loss: 1.0630 - accuracy: 0.8579 - val_loss: 1.0774 - val_accuracy: 0.
8555 - lr: 3.0000e-04
Epoch 37/60
212/212 [==============================] - 11s 50ms/step - loss: 1.0485 - accuracy: 0.8617 - val_loss: 1.0362 - val_accuracy: 0.
8733 - lr: 3.0000e-04
Epoch 38/60
212/212 [==============================] - 10s 49ms/step - loss: 1.0220 - accuracy: 0.8707 - val_loss: 4.6540 - val_accuracy: 0.
3102 - lr: 3.0000e-04
Epoch 39/60
212/212 [==============================] - 10s 49ms/step - loss: 1.0268 - accuracy: 0.8715 - val_loss: 1.1129 - val_accuracy: 0.
8591 - lr: 3.0000e-04
Epoch 40/60
212/212 [==============================] - 11s 50ms/step - loss: 1.0137 - accuracy: 0.8724 - val_loss: 1.0895 - val_accuracy: 0.
8496 - lr: 3.0000e-04
Epoch 41/60
212/212 [==============================] - 11s 50ms/step - loss: 0.9910 - accuracy: 0.8798 - val_loss: 0.9729 - val_accuracy: 0.
8893 - lr: 3.0000e-04
Epoch 42/60
212/212 [==============================] - 10s 49ms/step - loss: 1.0171 - accuracy: 0.8736 - val_loss: 6.2417 - val_accuracy: 0.
1208 - lr: 3.0000e-04
Epoch 43/60
212/212 [==============================] - 10s 49ms/step - loss: 0.9588 - accuracy: 0.8867 - val_loss: 2.0139 - val_accuracy: 0.
5204 - lr: 3.0000e-04
Epoch 44/60
212/212 [==============================] - 10s 49ms/step - loss: 1.0101 - accuracy: 0.8724 - val_loss: 1.0549 - val_accuracy: 0.
8680 - lr: 3.0000e-04
Epoch 45/60
212/212 [==============================] - 11s 50ms/step - loss: 0.9778 - accuracy: 0.8746 - val_loss: 5.4293 - val_accuracy: 0.
1658 - lr: 3.0000e-04
Epoch 46/60
212/212 [==============================] - 10s 49ms/step - loss: 0.9600 - accuracy: 0.8793 - val_loss: 1.0097 - val_accuracy: 0.
8739 - lr: 3.0000e-04
Epoch 47/60
212/212 [==============================] - 10s 49ms/step - loss: 0.9565 - accuracy: 0.8838 - val_loss: 4.6187 - val_accuracy: 0.
1308 - lr: 3.0000e-04
Epoch 48/60
212/212 [==============================] - 10s 49ms/step - loss: 0.9330 - accuracy: 0.8857 - val_loss: 1.2865 - val_accuracy: 0.
7762 - lr: 3.0000e-04
Epoch 49/60
212/212 [==============================] - 11s 50ms/step - loss: 0.8760 - accuracy: 0.9045 - val_loss: 0.8497 - val_accuracy: 0.
9207 - lr: 3.0000e-05
Epoch 50/60
212/212 [==============================] - 11s 50ms/step - loss: 0.8383 - accuracy: 0.9152 - val_loss: 0.8094 - val_accuracy: 0.
9325 - lr: 3.0000e-05
Epoch 51/60
212/212 [==============================] - 11s 50ms/step - loss: 0.7968 - accuracy: 0.9218 - val_loss: 0.7859 - val_accuracy: 0.
9307 - lr: 3.0000e-05
Epoch 52/60
212/212 [==============================] - 11s 50ms/step - loss: 0.7874 - accuracy: 0.9227 - val_loss: 0.7644 - val_accuracy: 0.
9361 - lr: 3.0000e-05
Epoch 53/60
212/212 [==============================] - 10s 49ms/step - loss: 0.7541 - accuracy: 0.9286 - val_loss: 0.7745 - val_accuracy: 0.
9278 - lr: 3.0000e-05
Epoch 54/60
212/212 [==============================] - 11s 51ms/step - loss: 0.7408 - accuracy: 0.9329 - val_loss: 0.7408 - val_accuracy: 0.
9355 - lr: 3.0000e-05
Epoch 55/60
212/212 [==============================] - 11s 50ms/step - loss: 0.7208 - accuracy: 0.9335 - val_loss: 0.7263 - val_accuracy: 0.
9384 - lr: 3.0000e-05
Epoch 56/60
212/212 [==============================] - 11s 50ms/step - loss: 0.6948 - accuracy: 0.9350 - val_loss: 0.7205 - val_accuracy: 0.
9366 - lr: 3.0000e-05
Epoch 57/60
212/212 [==============================] - 11s 50ms/step - loss: 0.6939 - accuracy: 0.9357 - val_loss: 0.7146 - val_accuracy: 0.
9372 - lr: 3.0000e-05
Epoch 58/60
212/212 [==============================] - 11s 50ms/step - loss: 0.6878 - accuracy: 0.9372 - val_loss: 0.6895 - val_accuracy: 0.
9384 - lr: 3.0000e-05
Epoch 59/60
212/212 [==============================] - 11s 50ms/step - loss: 0.6715 - accuracy: 0.9346 - val_loss: 0.6892 - val_accuracy: 0.
9390 - lr: 3.0000e-05
Epoch 60/60
212/212 [==============================] - 11s 50ms/step - loss: 0.6571 - accuracy: 0.9350 - val_loss: 0.6829 - val_accuracy: 0.
9337 - lr: 3.0000e-05
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