IRV2_on_GZ2_v7

May 5, 2022

[ ]:
```
import os
import pandas as pd
import numpy as np
import tensorflow as tf
import matplotlib.pyplot as plt
import zipfile
import io
from PIL import Image
import matplotlib.pyplot as plt
from skimage.transform import resize
from tensorflow import keras
from tensorflow.keras.models import Model, load_model, Sequential
from tensorflow.keras.layers import Input, Dense, Conv2D, Flatten
from tensorflow.keras.optimizers import SGD, Adam
from keras.applications.inception_resnet_v2 import InceptionResNetV2 as ␣
 ↪PretrainedModel,preprocess_input
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator,␣
 ↪array_to_img, img_to_array, load_img
from tensorflow.keras.callbacks import ModelCheckpoint, Callback, EarlyStopping
```

[ ]:
```
# zippath = '/content/drive/MyDrive/Major_Project/GZ-2/archive.zip'
# z = zipfile.ZipFile(zippath)
# imgname = 'images_gz2/images/233063.jpg'
# im = Image.open(io.BytesIO(z.read(imgname)))
# im_list = np.asarray(im)
# plt.imshow(im_list)
# plt.show()

# z.close()
```

[ ]:
```
# plt.figure(figsize=(16,4))
# for i in range(3):
#     plt.subplot(1,3,i+1)
#     plt.imshow(im_list[:,:,i])
#     plt.colorbar()
# plt.show()
```

[ ]:
```
# imgname = 'images_gz2/images/233063.jpg'
# img = load_img(imgname)
# data = img_to_array(img)
# samples = np.expand_dims(data, 0)
```

[ ]:
```
# def visualiseAugmentation(datagen):
#   it = datagen.flow(samples, batch_size=1)
#   plt.figure(figsize=(15,15))
#   for i in range(9):
#     plt.subplot(330 + 1 + i)
#     batch = it.next()
#     image = batch[0].astype('uint8')
#     plt.imshow(image)
#   plt.show()
```

[ ]:
```
# widthShift = ImageDataGenerator(width_shift_range=[-200,200])
# visualiseAugmentation(widthShift)
```

[ ]:
```
# zoomRange = ImageDataGenerator(zoom_range=[0.4, 0.7])
# visualiseAugmentation(zoomRange)
```

[ ]:
```
# rotation_range = ImageDataGenerator(rotation_range=90)
# visualiseAugmentation(rotation_range)
```

[ ]:
```
# shear_range = ImageDataGenerator(shear_range=0.7)
# visualiseAugmentation(shear_range)
```

[ ]:
```
def append_ext(fn):
    '''
    This function is used to take the GalaxyID from the CSV and append .jpg to␣
 ↪it in order to denote the image names.
    '''
    return fn + ".jpg"


traindf = pd.read_csv('D:/OneDrive/Major Project/HybridModel_37Classes/
 ↪GZ_2_Processed_classes.csv')

traindf["id"] = traindf['GalaxyID'].astype(str).apply(append_ext)
```

[ ]:
```
classes = [
    'Class1.1', 'Class1.2', 'Class1.3', 'Class2.1', 'Class2.2', 'Class3.1',
    'Class3.2', 'Class4.1', 'Class4.2', 'Class5.1', 'Class5.2', 'Class5.3',
    'Class5.4', 'Class6.1', 'Class6.2', 'Class7.1', 'Class7.2', 'Class7.3',
    'Class8.1', 'Class8.2', 'Class8.3', 'Class8.4', 'Class8.5', 'Class8.6',
    'Class8.7', 'Class9.1', 'Class9.2', 'Class9.3', 'Class10.1', 'Class10.2',
    'Class10.3', 'Class11.1', 'Class11.2', 'Class11.3', 'Class11.4',
```

```
    'Class11.5', 'Class11.6'
]
```

[ ]:
```
datagenerator = ImageDataGenerator(
    fill_mode='nearest',
    cval=0,
    rescale=1/255,
    rotation_range=25,
    shear_range=0.2,
    width_shift_range=[0.1, 0.15],
    height_shift_range=[0.1, 0.15],
    horizontal_flip=True,
    vertical_flip=True,
    zoom_range=[0.4, 0.7],
    validation_split=0.025)
```

[ ]:
```
train_generator = datagenerator.flow_from_dataframe(
    dataframe=traindf,
    directory="D:/Rahul Noronha/Shared Folder/Eighth Semester/Major Project/
 ↪Data/images",
    x_col="id",
    y_col=classes,
    subset="training",
    batch_size=64,
    seed=123,
    shuffle=True,
    class_mode="raw",
    target_size=(299, 299))

validation_generator = datagenerator.flow_from_dataframe(
    dataframe=traindf,
    directory="D:/Rahul Noronha/Shared Folder/Eighth Semester/Major Project/
 ↪Data/images",
    x_col="id",
    y_col=classes,
    subset="validation",
    batch_size=16,
    seed=123,
    shuffle=True,
    class_mode="raw",
    target_size=(299, 299))

STEP_SIZE_TRAIN = train_generator.n // train_generator.batch_size
STEP_SIZE_VALID = validation_generator.n // validation_generator.batch_size
```

```
D:\anaconda\envs\python37majorproject\lib\site-
packages\keras_preprocessing\image\dataframe_iterator.py:282: UserWarning: Found
```

```
108 invalid image filename(s) in x_col="id". These filename(s) will be ignored.
  .format(n_invalid, x_col)

Found 198632 validated image filenames.
Found 5093 validated image filenames.
```

[ ]:
```python
import os
import re
import sys
import time
import numpy as np
from typing import Any, List, Tuple, Union
from tensorflow.keras.datasets import mnist
from tensorflow.keras import backend as K
import tensorflow as tf
import tensorflow.keras
import tensorflow as tf
from tensorflow.keras.callbacks import EarlyStopping, \
  LearningRateScheduler, ModelCheckpoint
from tensorflow.keras import regularizers
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout, Flatten
from tensorflow.keras.layers import Conv2D, MaxPooling2D
from tensorflow.keras.models import load_model
import pickle
```

[ ]:
```python
def generate_output_dir(outdir, run_desc):
    prev_run_dirs = []
    if os.path.isdir(outdir):
        prev_run_dirs = [x for x in os.listdir(outdir) if os.path.isdir(\
            os.path.join(outdir, x))]
    prev_run_ids = [re.match(r'^\d+', x) for x in prev_run_dirs]
    prev_run_ids = [int(x.group()) for x in prev_run_ids if x is not None]
    cur_run_id = max(prev_run_ids, default=-1) + 1
    run_dir = os.path.join(outdir, f'{cur_run_id:05d}-{run_desc}')
    assert not os.path.exists(run_dir)
    os.makedirs(run_dir)
    return run_dir

# From StyleGAN2
class Logger(object):
    """Redirect stderr to stdout, optionally print stdout to a file, and
    optionally force flushing on both stdout and the file."""

    def __init__(self, file_name: str = None, file_mode: str = "w", \
                 should_flush: bool = True):
        self.file = None
```

```
        if file_name is not None:
            self.file = open(file_name, file_mode)

        self.should_flush = should_flush
        self.stdout = sys.stdout
        self.stderr = sys.stderr

        sys.stdout = self
        sys.stderr = self

    def __enter__(self) -> "Logger":
        return self

    def __exit__(self, exc_type: Any, exc_value: Any, \
                 traceback: Any) -> None:
        self.close()

    def write(self, text: str) -> None:
        """Write text to stdout (and a file) and optionally flush."""
        if len(text) == 0:
            return

        if self.file is not None:
            self.file.write(text)

        self.stdout.write(text)

        if self.should_flush:
            self.flush()

    def flush(self) -> None:
        """Flush written text to both stdout and a file, if open."""
        if self.file is not None:
            self.file.flush()

        self.stdout.flush()

    def close(self) -> None:
        """Flush, close possible files, and remove
            stdout/stderr mirroring."""
        self.flush()

        # if using multiple loggers, prevent closing in wrong order
        if sys.stdout is self:
            sys.stdout = self.stdout
        if sys.stderr is self:
            sys.stderr = self.stderr
```

```
        if self.file is not None:
            self.file.close()
```

[ ]:
```
outdir = "D:/OneDrive/Major Project/HybridModel_37Classes/params/"
run_desc = "test-train"
batch_size = 128
num_classes = len(classes)

run_dir = generate_output_dir(outdir, run_desc)
print(f"Results saved to: {run_dir}")
```

```
Results saved to: D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train
```

[ ]:
```
class MyModelCheckpoint(ModelCheckpoint):
  def __init__(self, *args, **kwargs):
    super().__init__(*args, **kwargs)

  def on_epoch_end(self, epoch, logs):
    super().on_epoch_end(epoch,logs)\

    # Also save the optimizer state
    filepath = self._get_file_path(epoch, logs=logs, batch=2)
    filepath = filepath.rsplit( ".", 1 )[ 0 ]
    filepath += ".pkl"

    with open(filepath, 'wb') as fp:
      pickle.dump(
        {
          'opt': hybridModel.optimizer.get_config(),
          'epoch': epoch+1
         # Add additional keys if you need to store more values
        }, fp, protocol=pickle.HIGHEST_PROTOCOL)
    print('\nEpoch %05d: saving optimizer to %s' % (epoch + 1, filepath))
```

[ ]:
```
def step_decay_schedule(initial_lr=1e-3, decay_factor=0.75, step_size=10):
    def schedule(epoch):
        return initial_lr * (decay_factor ** np.floor(epoch/step_size))
    return LearningRateScheduler(schedule)
```

[ ]:
```
# from tensorflow.keras.applications import DenseNet121, VGG16, ResNet50V2,␣
 ↪MobileNetV2, EfficientNetB0, Xception

img_shape = (299, 299, 3)
num_classes = len(classes)
```

```
def build_model(img_shape, num_classes):
    hybridModel = Sequential()

    pretrained_model = PretrainedModel(
            input_shape = img_shape,
            weights = 'imagenet',
            include_top = False

    )
    for layer in pretrained_model.layers:
            layer.trainable=False

    hybridModel.add(pretrained_model)
    hybridModel.add(Flatten())
    hybridModel.add(Dense(len(classes), activation='softmax'))
    optimizer = keras.optimizers.Adam()
    hybridModel.compile(optimizer, loss='mse', metrics=["accuracy"])
    return hybridModel

def train_model(hybridModel, initial_epoch=0, max_epochs=10):
    start_time = time.time()

    checkpoint_cb = MyModelCheckpoint(
        os.path.join(run_dir, 'model-{epoch:02d}-{val_loss:.2f}.hdf5'),
        monitor='val_loss',verbose=1)

    lr_sched_cb = step_decay_schedule(initial_lr=3.9922e-21, decay_factor=0.75,␣
 ↪\
                                      step_size=9)
    cb = [checkpoint_cb, lr_sched_cb]

    hist = hybridModel.fit(
    train_generator,
    steps_per_epoch=STEP_SIZE_TRAIN,
    validation_data=validation_generator,
    validation_steps=STEP_SIZE_VALID,
    epochs=max_epochs,
    initial_epoch = initial_epoch,
    callbacks=cb)
```

[ ]:
```
# with Logger(os.path.join(run_dir, 'log.txt')):
#   hybridModel = build_model(img_shape, num_classes)
#   train_model(hybridModel)
```

[ ]:
```
# !ls '/content/drive/MyDrive/Major Project/Galaxy_Morphology/Data/GalaxyZoo2/
 ↪model/params'
```

[ ]:
```
MODEL_PATH = 'D:/OneDrive/Major Project/HybridModel_37Classes/params/
 ↪00009-test-train/model-72-0.15.hdf5'
OPT_PATH = 'D:/OneDrive/Major Project/HybridModel_37Classes/params/
 ↪00009-test-train/model-72-0.15.pkl'
```

[ ]:
```
def load_model_data(model_path, opt_path):
    model = load_model(model_path)
    with open(opt_path, 'rb') as fp:
      d = pickle.load(fp)
      epoch = d['epoch']
      opt = d['opt']
      return epoch, model, opt

epoch, hybridModel, opt = load_model_data(MODEL_PATH, OPT_PATH)
hybridModel.compile(optimizer=tf.keras.optimizers.Adam.from_config(opt),␣
 ↪loss='mse', metrics=["accuracy"])
with Logger(os.path.join(run_dir, 'log.txt')):
  train_model(hybridModel, initial_epoch=epoch, max_epochs=100)
```

```
Epoch 73/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3704
Epoch 73: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-73-0.15.hdf5

Epoch 00073: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-73-0.15.pkl
3103/3103 [==============================] - 9043s 3s/step - loss: 0.1562 -
accuracy: 0.3704 - val_loss: 0.1484 - val_accuracy: 0.2824 - lr: 3.9967e-22
Epoch 74/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3716
Epoch 74: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-74-0.15.hdf5

Epoch 00074: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-74-0.15.pkl
3103/3103 [==============================] - 5514s 2s/step - loss: 0.1562 -
accuracy: 0.3716 - val_loss: 0.1484 - val_accuracy: 0.2822 - lr: 3.9967e-22
Epoch 75/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3717
Epoch 75: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-75-0.15.hdf5

Epoch 00075: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-75-0.15.pkl
```

```
3103/3103 [==============================] - 3517s 1s/step - loss: 0.1562 -
accuracy: 0.3717 - val_loss: 0.1484 - val_accuracy: 0.2921 - lr: 3.9967e-22
Epoch 76/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3708
Epoch 76: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-76-0.15.hdf5

Epoch 00076: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-76-0.15.pkl
3103/3103 [==============================] - 3788s 1s/step - loss: 0.1562 -
accuracy: 0.3708 - val_loss: 0.1484 - val_accuracy: 0.2828 - lr: 3.9967e-22
Epoch 77/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3708
Epoch 77: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-77-0.15.hdf5

Epoch 00077: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-77-0.15.pkl
3103/3103 [==============================] - 3798s 1s/step - loss: 0.1562 -
accuracy: 0.3708 - val_loss: 0.1484 - val_accuracy: 0.2848 - lr: 3.9967e-22
Epoch 78/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3720
Epoch 78: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-78-0.15.hdf5

Epoch 00078: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-78-0.15.pkl
3103/3103 [==============================] - 3594s 1s/step - loss: 0.1562 -
accuracy: 0.3720 - val_loss: 0.1484 - val_accuracy: 0.2858 - lr: 3.9967e-22
Epoch 79/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3720
Epoch 79: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-79-0.15.hdf5

Epoch 00079: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-79-0.15.pkl
3103/3103 [==============================] - 3394s 1s/step - loss: 0.1562 -
accuracy: 0.3720 - val_loss: 0.1485 - val_accuracy: 0.2856 - lr: 3.9967e-22
Epoch 80/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3716
Epoch 80: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-80-0.15.hdf5
```

```
Epoch 00080: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-80-0.15.pkl
3103/3103 [==============================] - 3387s 1s/step - loss: 0.1562 -
accuracy: 0.3716 - val_loss: 0.1484 - val_accuracy: 0.2869 - lr: 3.9967e-22
Epoch 81/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3705
Epoch 81: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-81-0.15.hdf5

Epoch 00081: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-81-0.15.pkl
3103/3103 [==============================] - 6415s 2s/step - loss: 0.1562 -
accuracy: 0.3705 - val_loss: 0.1484 - val_accuracy: 0.2811 - lr: 3.9967e-22
Epoch 82/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3712
Epoch 82: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-82-0.15.hdf5

Epoch 00082: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-82-0.15.pkl
3103/3103 [==============================] - 6792s 2s/step - loss: 0.1562 -
accuracy: 0.3712 - val_loss: 0.1484 - val_accuracy: 0.2869 - lr: 2.9975e-22
Epoch 83/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3703
Epoch 83: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-83-0.15.hdf5

Epoch 00083: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-83-0.15.pkl
3103/3103 [==============================] - 6354s 2s/step - loss: 0.1562 -
accuracy: 0.3703 - val_loss: 0.1484 - val_accuracy: 0.2932 - lr: 2.9975e-22
Epoch 84/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3709
Epoch 84: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-84-0.15.hdf5

Epoch 00084: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-84-0.15.pkl
3103/3103 [==============================] - 4343s 1s/step - loss: 0.1562 -
accuracy: 0.3709 - val_loss: 0.1484 - val_accuracy: 0.2848 - lr: 2.9975e-22
Epoch 85/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3713
Epoch 85: saving model to D:/OneDrive/Major
```

```
Project/HybridModel_37Classes/params/00010-test-train\model-85-0.15.hdf5

Epoch 00085: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-85-0.15.pkl
3103/3103 [==============================] - 4318s 1s/step - loss: 0.1562 -
accuracy: 0.3713 - val_loss: 0.1484 - val_accuracy: 0.2836 - lr: 2.9975e-22
Epoch 86/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3718
Epoch 86: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-86-0.15.hdf5

Epoch 00086: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-86-0.15.pkl
3103/3103 [==============================] - 3866s 1s/step - loss: 0.1562 -
accuracy: 0.3718 - val_loss: 0.1484 - val_accuracy: 0.2783 - lr: 2.9975e-22
Epoch 87/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3714
Epoch 87: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-87-0.15.hdf5

Epoch 00087: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-87-0.15.pkl
3103/3103 [==============================] - 7551s 2s/step - loss: 0.1562 -
accuracy: 0.3714 - val_loss: 0.1484 - val_accuracy: 0.2891 - lr: 2.9975e-22
Epoch 88/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3709
Epoch 88: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-88-0.15.hdf5

Epoch 00088: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-88-0.15.pkl
3103/3103 [==============================] - 4512s 1s/step - loss: 0.1562 -
accuracy: 0.3709 - val_loss: 0.1484 - val_accuracy: 0.2875 - lr: 2.9975e-22
Epoch 89/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3719
Epoch 89: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-89-0.15.hdf5

Epoch 00089: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-89-0.15.pkl
3103/3103 [==============================] - 4748s 2s/step - loss: 0.1562 -
accuracy: 0.3719 - val_loss: 0.1484 - val_accuracy: 0.2905 - lr: 2.9975e-22
Epoch 90/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
```

```
0.3711
Epoch 90: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-90-0.15.hdf5

Epoch 00090: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-90-0.15.pkl
3103/3103 [==============================] - 6426s 2s/step - loss: 0.1562 -
accuracy: 0.3711 - val_loss: 0.1484 - val_accuracy: 0.2868 - lr: 2.9975e-22
Epoch 91/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3708
Epoch 91: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-91-0.15.hdf5

Epoch 00091: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-91-0.15.pkl
3103/3103 [==============================] - 7142s 2s/step - loss: 0.1562 -
accuracy: 0.3708 - val_loss: 0.1484 - val_accuracy: 0.2732 - lr: 2.2481e-22
Epoch 92/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3698
Epoch 92: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-92-0.15.hdf5

Epoch 00092: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-92-0.15.pkl
3103/3103 [==============================] - 3785s 1s/step - loss: 0.1562 -
accuracy: 0.3698 - val_loss: 0.1484 - val_accuracy: 0.2875 - lr: 2.2481e-22
Epoch 93/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3715
Epoch 93: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-93-0.15.hdf5

Epoch 00093: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-93-0.15.pkl
3103/3103 [==============================] - 6004s 2s/step - loss: 0.1562 -
accuracy: 0.3715 - val_loss: 0.1484 - val_accuracy: 0.2840 - lr: 2.2481e-22
Epoch 94/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3707
Epoch 94: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-94-0.15.hdf5

Epoch 00094: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-94-0.15.pkl
3103/3103 [==============================] - 4784s 2s/step - loss: 0.1562 -
accuracy: 0.3707 - val_loss: 0.1484 - val_accuracy: 0.2915 - lr: 2.2481e-22
```

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Epoch 95/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3713
Epoch 95: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-95-0.15.hdf5

Epoch 00095: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-95-0.15.pkl
3103/3103 [==============================] - 3784s 1s/step - loss: 0.1562 -
accuracy: 0.3713 - val_loss: 0.1485 - val_accuracy: 0.2814 - lr: 2.2481e-22
Epoch 96/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3715
Epoch 96: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-96-0.15.hdf5

Epoch 00096: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-96-0.15.pkl
3103/3103 [==============================] - 3339s 1s/step - loss: 0.1562 -
accuracy: 0.3715 - val_loss: 0.1484 - val_accuracy: 0.2881 - lr: 2.2481e-22
Epoch 97/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3724
Epoch 97: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-97-0.15.hdf5

Epoch 00097: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-97-0.15.pkl
3103/3103 [==============================] - 3248s 1s/step - loss: 0.1562 -
accuracy: 0.3724 - val_loss: 0.1484 - val_accuracy: 0.2836 - lr: 2.2481e-22
Epoch 98/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3723
Epoch 98: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-98-0.15.hdf5

Epoch 00098: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-98-0.15.pkl
3103/3103 [==============================] - 3881s 1s/step - loss: 0.1562 -
accuracy: 0.3723 - val_loss: 0.1484 - val_accuracy: 0.2858 - lr: 2.2481e-22
Epoch 99/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3724
Epoch 99: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-99-0.15.hdf5

Epoch 00099: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-99-0.15.pkl
```

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3103/3103 [==============================] - 4086s 1s/step - loss: 0.1562 -
accuracy: 0.3724 - val_loss: 0.1484 - val_accuracy: 0.2877 - lr: 2.2481e-22
Epoch 100/100
3103/3103 [==============================] - ETA: 0s - loss: 0.1562 - accuracy:
0.3712
Epoch 100: saving model to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-100-0.15.hdf5

Epoch 00100: saving optimizer to D:/OneDrive/Major
Project/HybridModel_37Classes/params/00010-test-train\model-100-0.15.pkl
3103/3103 [==============================] - 3817s 1s/step - loss: 0.1562 -
accuracy: 0.3712 - val_loss: 0.1484 - val_accuracy: 0.2889 - lr: 1.6861e-22
```