Image classification without the use of machine learning

Day and Night Image Classifier

The day/night image dataset consists of 200 RGB color images in two categories: day and night. There are equal numbers of each example: 100 day images and 100 night images.

We're trying to build a classifier that can accurately label these images as day or night, and that relies on finding distinguishing features between the two types of images!

Note: All images come from the AMOS dataset (Archive of Many Outdoor Scenes).

Import resources

Before we get started on the project code, import the libraries that we'll need.

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
import os
import glob #for loading images from a directory
import matplotlib.image as mpimg
import matplotlib.pyplot as plt
import cv2
import random
import numpy as np

import matplotlib.pyplot as plt
import seaborn as sns

import keras
from keras.models import Sequential
from keras.layers import Dense, Conv2D , MaxPool2D , Flatten , Dropout

from keras.preprocessing.image import ImageDataGenerator
from keras.optimizers import adam_v2

from sklearn.metrics import classification_report,confusion_matrix

import tensorflow as tf

import os

# Image data directories
image_dir_training = "/content/drive/MyDrive/images/training"
image_dir_test = "/content/drive/MyDrive/images/test/"
```

Step 1: Load the datasets and visualize

These first few lines of code will load the training day/night images and store all of them in a variable, IMAGE_LIST. This list contains the images and their associated label ("day" or "night").

For example, the first image-label pair in IMAGE_LIST can be accessed by index: IMAGE_LIST[0][:].

```python
labels = ['day', 'night']
img_size = 224
def get_data(data_dir):
    data = []
    for label in labels:
        path = os.path.join(data_dir, label)
        class_num = labels.index(label)
        print(path)
        for img in os.listdir(path):
            try:

                img_arr = cv2.imread(os.path.join(path, img))[...,::-1] #convert BGR to RGB format
                print(img_arr)
                resized_arr = cv2.resize(img_arr, (img_size, img_size)) # Reshaping images to preferred size
                data.append([resized_arr, class_num])
            except Exception as e:
                print(e)
    return np.array(data)

# Load training data
train = get_data('/content/drive/MyDrive/images/training')
val = get_data('/content/drive/MyDrive/images/test')

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/content/drive/MyDrive/images/test/day
```

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/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:18:
VisibleDeprecationWarning: Creating an ndarray from ragged nested
sequences (which is a list-or-tuple of lists-or-tuples-or ndarrays
with different lengths or shapes) is deprecated. If you meant to do
this, you must specify 'dtype=object' when creating the ndarray.
```

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Streaming output truncated to the last 5000 lines.
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 [28 25 34]]]
[[[ 2  2  0]
  [ 2  2  0]
  [ 2  2  0]

  ...
  [ 1  1  0]
  [ 1  1  0]
  [ 1  1  0]]
```

```
[[ 2   2   0]
 [ 2   2   0]
 [ 2   2   0]

 ...

 [ 1   1   0]
 [ 1   1   0]
 [ 1   1   0]]

[[ 2   2   0]
 [ 2   2   0]
 [ 2   2   0]

 ...

 [ 1   1   0]
 [ 1   1   0]
 [ 1   1   0]]


 ...

[[36  77  61]
 [36  77  61]
 [38  74  60]

 ...

 [ 7   6   2]
 [ 6   5   1]
 [ 6   5   1]]

[[36  77  61]
 [33  74  58]
 [38  74  60]

 ...

 [ 7   6   2]
 [ 6   5   1]
 [ 6   5   1]]

[[35  76  60]
 [30  71  55]
 [38  74  60]

 ...

 [ 7   6   2]
 [ 6   5   1]
 [ 5   4   0]]]
[[[25  23  26]
 [24  22  25]
 [22  20  23]

 ...

 [34  29  51]
 [28  22  48]
 [32  26  52]]
```

```
[[24 22 25]
 [24 22 25]
 [22 20 23]
 ...
 [33 28 50]
 [28 23 46]
 [32 26 52]]

[[24 22 25]
 [23 21 24]
 [23 21 24]
 ...
 [33 28 50]
 [28 23 46]
 [31 26 49]]

...

[[29 27 28]
 [25 23 24]
 [23 21 22]
 ...
 [28 24 38]
 [27 23 37]
 [25 21 35]]

[[30 28 29]
 [27 25 26]
 [26 24 25]
 ...
 [28 24 38]
 [27 23 37]
 [26 22 36]]

[[30 29 27]
 [23 22 20]
 [27 26 24]
 ...
 [25 21 35]
 [25 21 35]
 [26 22 36]]]
[[[108 100  87]
 [ 91  83  70]
 [100  92  79]
 ...
 [ 42  39  24]
 [ 45  42  27]
 [ 64  61  46]]
```

```
[[ 59  51  38]
 [ 91  83  70]
 [ 59  51  38]

 ...
 [ 50  47  32]
 [ 44  41  26]
 [ 52  49  34]]

[[ 87  79  66]
 [ 90  82  69]
 [ 95  87  74]

 ...
 [ 48  45  30]
 [ 41  38  23]
 [ 44  41  26]]


...

[[ 99  99  75]
 [100 100  76]
 [ 80  78  55]

 ...
 [ 55  56  42]
 [ 54  55  41]
 [ 71  72  58]]

[[108 111  90]
 [109 113  90]
 [125 127 106]

 ...
 [ 56  57  43]
 [ 56  57  43]
 [ 74  75  61]]

[[ 92  97  77]
 [105 110  88]
 [ 87  90  71]

 ...
 [ 59  60  46]
 [ 55  56  42]
 [ 61  62  48]]]
[[[25 24 32]
  [24 23 31]
  [22 21 29]

  ...
  [27 23 50]
  [29 24 54]
  [29 24 54]]
```

```
[[25 24 32]
 [24 23 31]
 [22 21 29]
 ...
 [29 25 52]
 [32 28 55]
 [33 29 56]]

[[25 24 32]
 [24 23 31]
 [23 22 30]
 ...
 [30 26 51]
 [35 31 56]
 [36 32 57]]

...

[[29 23 33]
 [29 23 33]
 [29 24 31]
 ...
 [24 21 32]
 [25 21 35]
 [30 26 40]]

[[25 19 29]
 [25 19 29]
 [26 21 28]
 ...
 [25 22 33]
 [25 21 35]
 [29 25 39]]

[[32 26 36]
 [31 25 35]
 [31 26 33]
 ...
 [33 30 41]
 [23 19 33]
 [26 22 36]]]
```

Step 2: Preprocess the data input images.

This function takes in a list of image-label pairs and outputs a **standardized** list of resized images and numerical labels.

1. Resizing every image to a standard size

2. Encode the target variables

```python
x_train = []
y_train = []
x_val = []
y_val = []

for feature, label in train:
  x_train.append(feature)
  y_train.append(label)

for feature, label in val:
  x_val.append(feature)
  y_val.append(label)

# Normalize the data
x_train = np.array(x_train) / 255
x_val = np.array(x_val) / 255

x_train.reshape(-1, img_size, img_size, 1)
y_train = np.array(y_train)

x_val.reshape(-1, img_size, img_size, 1)
y_val = np.array(y_val)
```

Step 3: Feature Extraction

Let's try to create a feature that represents the brightness in an image. We'll be extracting the **average brightness** using HSV colorspace. Specifically, we'll use the V channel (a measure of brightness), add up the pixel values in the V channel, then divide that sum by the area of the image to get the average Value of the image.

```python
datagen = ImageDataGenerator(
        featurewise_center=False,  # set input mean to 0 over the dataset
        samplewise_center=False,  # set each sample mean to 0
        featurewise_std_normalization=False,  # divide inputs by std of the dataset
        samplewise_std_normalization=False,  # divide each input by its std
        zca_whitening=False,  # apply ZCA whitening
        rotation_range = 30,  # randomly rotate images in the range (degrees, 0 to 180)
        zoom_range = 0.2, # Randomly zoom image
        width_shift_range=0.1,  # randomly shift images horizontally (fraction of total width)
        height_shift_range=0.1,  # randomly shift images vertically (fraction of total height)
        horizontal_flip = True,  # randomly flip images
        vertical_flip=False)  # randomly flip images
```

```
datagen.fit(x_train)
```

Step 4: Build the classifier

We'll turn our average brightness feature into a classifier that takes in a standardized image and returns a `predicted_label` for that image. This `estimate_label` function should return a value: 0 or 1 (night or day, respectively).

```python
model = Sequential()
model.add(Conv2D(32,3,padding="same", activation="relu",
input_shape=(224,224,3)))
model.add(MaxPool2D())

model.add(Conv2D(32, 3, padding="same", activation="relu"))
model.add(MaxPool2D())

model.add(Conv2D(64, 3, padding="same", activation="relu"))
model.add(MaxPool2D())
model.add(Dropout(0.4))

model.add(Flatten())
model.add(Dense(128,activation="relu"))
model.add(Dense(2, activation="softmax"))

model.summary()
```

Model: "sequential"

```
_____
 Layer (type)               Output Shape              Param #
=================================================================
 conv2d (Conv2D)            (None, 224, 224, 32)      896

 max_pooling2d (MaxPooling2D  (None, 112, 112, 32)     0
 )

 conv2d_1 (Conv2D)          (None, 112, 112, 32)      9248

 max_pooling2d_1 (MaxPooling  (None, 56, 56, 32)       0
 2D)

 conv2d_2 (Conv2D)          (None, 56, 56, 64)        18496

 max_pooling2d_2 (MaxPooling  (None, 28, 28, 64)       0
 2D)

 dropout (Dropout)          (None, 28, 28, 64)        0

 flatten (Flatten)          (None, 50176)             0
```

```
 dense (Dense)                  (None, 128)                   6422656

 dense_1 (Dense)                (None, 2)                     258

=================================================================
Total params: 6,451,554
Trainable params: 6,451,554
Non-trainable params: 0

_____

from keras.optimizers import Adam
opt = Adam(learning_rate=0.000001)
model.compile(optimizer = opt , loss =
tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True) ,
metrics = ['accuracy'])

history = model.fit(x_train,y_train,epochs = 50 , validation_data =
(x_val, y_val))

Epoch 1/50

/usr/local/lib/python3.7/dist-packages/tensorflow/python/util/
dispatch.py:1082: UserWarning: "`sparse_categorical_crossentropy`
received `from_logits=True`, but the `output` argument was produced by
a sigmoid or softmax activation and thus does not represent logits.
Was this intended?"
  return dispatch_target(*args, **kwargs)

8/8 [==============================] - 21s 2s/step - loss: 0.7079 -
accuracy: 0.4750 - val_loss: 0.6972 - val_accuracy: 0.5000
Epoch 2/50
8/8 [==============================] - 19s 2s/step - loss: 0.6938 -
accuracy: 0.5292 - val_loss: 0.6835 - val_accuracy: 0.6187
Epoch 3/50
8/8 [==============================] - 19s 2s/step - loss: 0.6814 -
accuracy: 0.6250 - val_loss: 0.6711 - val_accuracy: 0.7563
Epoch 4/50
8/8 [==============================] - 19s 2s/step - loss: 0.6692 -
accuracy: 0.6833 - val_loss: 0.6598 - val_accuracy: 0.7688
Epoch 5/50
8/8 [==============================] - 19s 2s/step - loss: 0.6545 -
accuracy: 0.7750 - val_loss: 0.6496 - val_accuracy: 0.7437
Epoch 6/50
8/8 [==============================] - 19s 2s/step - loss: 0.6456 -
accuracy: 0.7375 - val_loss: 0.6396 - val_accuracy: 0.7250
Epoch 7/50
8/8 [==============================] - 19s 2s/step - loss: 0.6351 -
accuracy: 0.7208 - val_loss: 0.6303 - val_accuracy: 0.7063
Epoch 8/50
8/8 [==============================] - 19s 2s/step - loss: 0.6232 -
```

```
accuracy: 0.7333 - val_loss: 0.6213 - val_accuracy: 0.7000
Epoch 9/50
8/8 [==============================] - 19s 2s/step - loss: 0.6184 -
accuracy: 0.7375 - val_loss: 0.6125 - val_accuracy: 0.7000
Epoch 10/50
8/8 [==============================] - 19s 2s/step - loss: 0.6074 -
accuracy: 0.7292 - val_loss: 0.6040 - val_accuracy: 0.6938
Epoch 11/50
8/8 [==============================] - 19s 2s/step - loss: 0.6024 -
accuracy: 0.7250 - val_loss: 0.5955 - val_accuracy: 0.7000
Epoch 12/50
8/8 [==============================] - 19s 2s/step - loss: 0.5921 -
accuracy: 0.7417 - val_loss: 0.5873 - val_accuracy: 0.7063
Epoch 13/50
8/8 [==============================] - 19s 2s/step - loss: 0.5814 -
accuracy: 0.7667 - val_loss: 0.5793 - val_accuracy: 0.7125
Epoch 14/50
8/8 [==============================] - 20s 2s/step - loss: 0.5735 -
accuracy: 0.7708 - val_loss: 0.5712 - val_accuracy: 0.7125
Epoch 15/50
8/8 [==============================] - 22s 3s/step - loss: 0.5675 -
accuracy: 0.7375 - val_loss: 0.5631 - val_accuracy: 0.7125
Epoch 16/50
8/8 [==============================] - 19s 2s/step - loss: 0.5579 -
accuracy: 0.7917 - val_loss: 0.5551 - val_accuracy: 0.7125
Epoch 17/50
8/8 [==============================] - 19s 2s/step - loss: 0.5436 -
accuracy: 0.8125 - val_loss: 0.5471 - val_accuracy: 0.7250
Epoch 18/50
8/8 [==============================] - 19s 2s/step - loss: 0.5387 -
accuracy: 0.8208 - val_loss: 0.5389 - val_accuracy: 0.7250
Epoch 19/50
8/8 [==============================] - 19s 2s/step - loss: 0.5302 -
accuracy: 0.8333 - val_loss: 0.5310 - val_accuracy: 0.7500
Epoch 20/50
8/8 [==============================] - 19s 2s/step - loss: 0.5209 -
accuracy: 0.8333 - val_loss: 0.5231 - val_accuracy: 0.7563
Epoch 21/50
8/8 [==============================] - 19s 2s/step - loss: 0.5125 -
accuracy: 0.8375 - val_loss: 0.5150 - val_accuracy: 0.7688
Epoch 22/50
8/8 [==============================] - 19s 2s/step - loss: 0.5026 -
accuracy: 0.8333 - val_loss: 0.5070 - val_accuracy: 0.7750
Epoch 23/50
8/8 [==============================] - 20s 2s/step - loss: 0.4963 -
accuracy: 0.8458 - val_loss: 0.4992 - val_accuracy: 0.7812
Epoch 24/50
8/8 [==============================] - 19s 2s/step - loss: 0.4860 -
accuracy: 0.8500 - val_loss: 0.4914 - val_accuracy: 0.8000
Epoch 25/50
```

```
8/8 [==============================] - 19s 2s/step - loss: 0.4765 -
accuracy: 0.8458 - val_loss: 0.4839 - val_accuracy: 0.8250
Epoch 26/50
8/8 [==============================] - 19s 2s/step - loss: 0.4692 -
accuracy: 0.8542 - val_loss: 0.4767 - val_accuracy: 0.8313
Epoch 27/50
8/8 [==============================] - 19s 2s/step - loss: 0.4601 -
accuracy: 0.8667 - val_loss: 0.4694 - val_accuracy: 0.8313
Epoch 28/50
8/8 [==============================] - 19s 2s/step - loss: 0.4490 -
accuracy: 0.8667 - val_loss: 0.4623 - val_accuracy: 0.8375
Epoch 29/50
8/8 [==============================] - 19s 2s/step - loss: 0.4472 -
accuracy: 0.8708 - val_loss: 0.4553 - val_accuracy: 0.8438
Epoch 30/50
8/8 [==============================] - 19s 2s/step - loss: 0.4370 -
accuracy: 0.8833 - val_loss: 0.4483 - val_accuracy: 0.8438
Epoch 31/50
8/8 [==============================] - 19s 2s/step - loss: 0.4286 -
accuracy: 0.8750 - val_loss: 0.4417 - val_accuracy: 0.8500
Epoch 32/50
8/8 [==============================] - 19s 2s/step - loss: 0.4193 -
accuracy: 0.8792 - val_loss: 0.4353 - val_accuracy: 0.8500
Epoch 33/50
8/8 [==============================] - 19s 2s/step - loss: 0.4075 -
accuracy: 0.8875 - val_loss: 0.4290 - val_accuracy: 0.8500
Epoch 34/50
8/8 [==============================] - 19s 2s/step - loss: 0.4016 -
accuracy: 0.8792 - val_loss: 0.4229 - val_accuracy: 0.8500
Epoch 35/50
8/8 [==============================] - 19s 2s/step - loss: 0.3955 -
accuracy: 0.8833 - val_loss: 0.4168 - val_accuracy: 0.8750
Epoch 36/50
8/8 [==============================] - 19s 2s/step - loss: 0.3936 -
accuracy: 0.8833 - val_loss: 0.4108 - val_accuracy: 0.8813
Epoch 37/50
8/8 [==============================] - 19s 2s/step - loss: 0.3849 -
accuracy: 0.8792 - val_loss: 0.4049 - val_accuracy: 0.8875
Epoch 38/50
8/8 [==============================] - 19s 2s/step - loss: 0.3750 -
accuracy: 0.9042 - val_loss: 0.3990 - val_accuracy: 0.8938
Epoch 39/50
8/8 [==============================] - 19s 2s/step - loss: 0.3728 -
accuracy: 0.8958 - val_loss: 0.3931 - val_accuracy: 0.9062
Epoch 40/50
8/8 [==============================] - 19s 2s/step - loss: 0.3632 -
accuracy: 0.9000 - val_loss: 0.3873 - val_accuracy: 0.9062
Epoch 41/50
8/8 [==============================] - 19s 2s/step - loss: 0.3579 -
accuracy: 0.9000 - val_loss: 0.3817 - val_accuracy: 0.9062
```

```
Epoch 42/50
8/8 [==============================] - 19s 2s/step - loss: 0.3520 -
accuracy: 0.9042 - val_loss: 0.3761 - val_accuracy: 0.9125
Epoch 43/50
8/8 [==============================] - 19s 2s/step - loss: 0.3450 -
accuracy: 0.9042 - val_loss: 0.3707 - val_accuracy: 0.9438
Epoch 44/50
8/8 [==============================] - 19s 2s/step - loss: 0.3394 -
accuracy: 0.9208 - val_loss: 0.3653 - val_accuracy: 0.9438
Epoch 45/50
8/8 [==============================] - 19s 2s/step - loss: 0.3350 -
accuracy: 0.9083 - val_loss: 0.3599 - val_accuracy: 0.9438
Epoch 46/50
8/8 [==============================] - 19s 2s/step - loss: 0.3319 -
accuracy: 0.9167 - val_loss: 0.3546 - val_accuracy: 0.9438
Epoch 47/50
8/8 [==============================] - 21s 3s/step - loss: 0.3242 -
accuracy: 0.9125 - val_loss: 0.3494 - val_accuracy: 0.9438
Epoch 48/50
8/8 [==============================] - 19s 2s/step - loss: 0.3181 -
accuracy: 0.9375 - val_loss: 0.3446 - val_accuracy: 0.9438
Epoch 49/50
8/8 [==============================] - 19s 2s/step - loss: 0.3105 -
accuracy: 0.9417 - val_loss: 0.3399 - val_accuracy: 0.9438
Epoch 50/50
8/8 [==============================] - 19s 2s/step - loss: 0.3027 -
accuracy: 0.9708 - val_loss: 0.3354 - val_accuracy: 0.9500
```

Step 5: Evaluate the Classifier and Optimize

Here is where we test your classification algorithm using our test set of data that we set aside at the beginning of the notebook! Below, we load in the test dataset, standardize it using the standardize function you defined above, and then **shuffle** it; this ensures that order will not play a role in testing accuracy.

```
acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
loss = history.history['loss']
val_loss = history.history['val_loss']

epochs_range = range(50)

plt.figure(figsize=(15, 15))
plt.subplot(2, 2, 1)
plt.plot(epochs_range, acc, label='Training Accuracy')
plt.plot(epochs_range, val_acc, label='Validation Accuracy')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy')

plt.subplot(2, 2, 2)
```
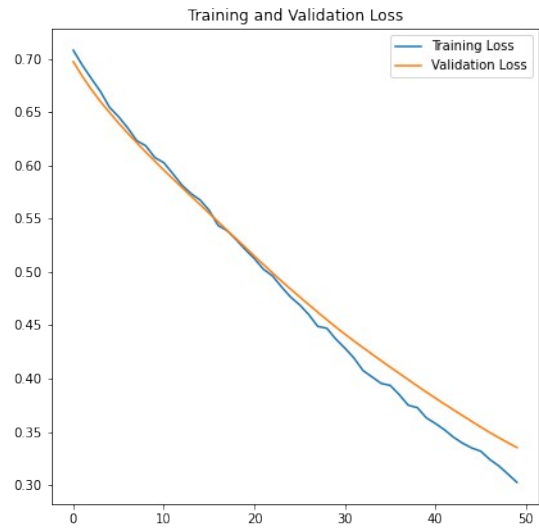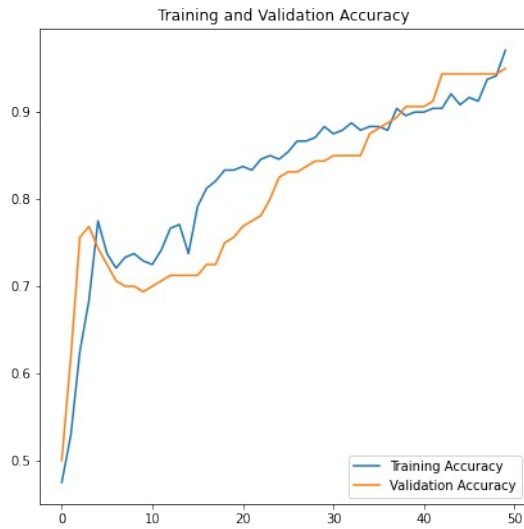
```
plt.plot(epochs_range, loss, label='Training Loss')
plt.plot(epochs_range, val_loss, label='Validation Loss')
plt.legend(loc='upper right')
plt.title('Training and Validation Loss')
plt.show()
```

Tasks:

Task 1: Execute the above code properly.

Task 2: Now, implement the image classification with given dataset using machine learning. Also, calculate the accuracy of the model.

Task 3: Understand and explain what did you analyze. Make a detailed analysis report. Also, cover all of the following questions.

1) explain when we should use Machine Learning and when not.

2) Compare the accuracy of both the way. Also, explain why you are getting the difference in accuracy.

3) Why we use Machine Learning rather than just software development?

4) How do you improve the performance of a model and why we need to improve the model performance?

(Submit the PDF of the report)

Task 4: Implement the above image classification code without the use of machine learning, but use different dataset.

Task 5: Implement any other code such as prediction without the use of machine learning.