CS156 (Introduction to AI), Fall 2021

Homework 8 submission

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Any special notes or anything you would like to communicate to me about this homework submission goes in here.

References and sources

List all your references and sources here. This includes all sites/discussion boards/blogs/posts/etc. where you grabbed some code examples.

Solution

Load libraries and set random number generator seed

In [3]:

```
import numpy as np
import tensorflow as tf
from tensorflow import keras
import matplotlib.pyplot as plt
from tensorflow.keras import layers
import matplotlib.pyplot as plt
import itertools
```

In [4]:

```
np.random.seed(42)
```

Code the solution

In [5]:

```
# load training, validation and test images,
image_size = (180, 180)
batch_size = 32

train_ds = tf.keras.preprocessing.image_dataset_from_directory(
    "./flowers/training",
    validation_split=0.2,
    labels='inferred',
    label_mode='categorical',
    subset="training",
    seed=42,
    image_size=image_size,
    batch_size=batch_size,
)
val_ds = tf.keras.preprocessing.image_dataset_from_directory(
    "./flowers/training",
    validation_split=0.2,
    labels='inferred',
    label_mode='categorical',
    subset="validation",
    seed=42,
    image_size=image_size,
    batch_size=batch_size,
)

test_ds = tf.keras.preprocessing.image_dataset_from_directory(
    "./flowers/test",
    labels='inferred',
    label_mode='categorical',
    seed=42,
    image_size=image_size,
    batch_size=1,
)
```

```
Found 3456 files belonging to 5 classes.
Using 2765 files for training.
Found 3456 files belonging to 5 classes.
Using 691 files for validation.
Found 861 files belonging to 5 classes.
```

In [ ]:

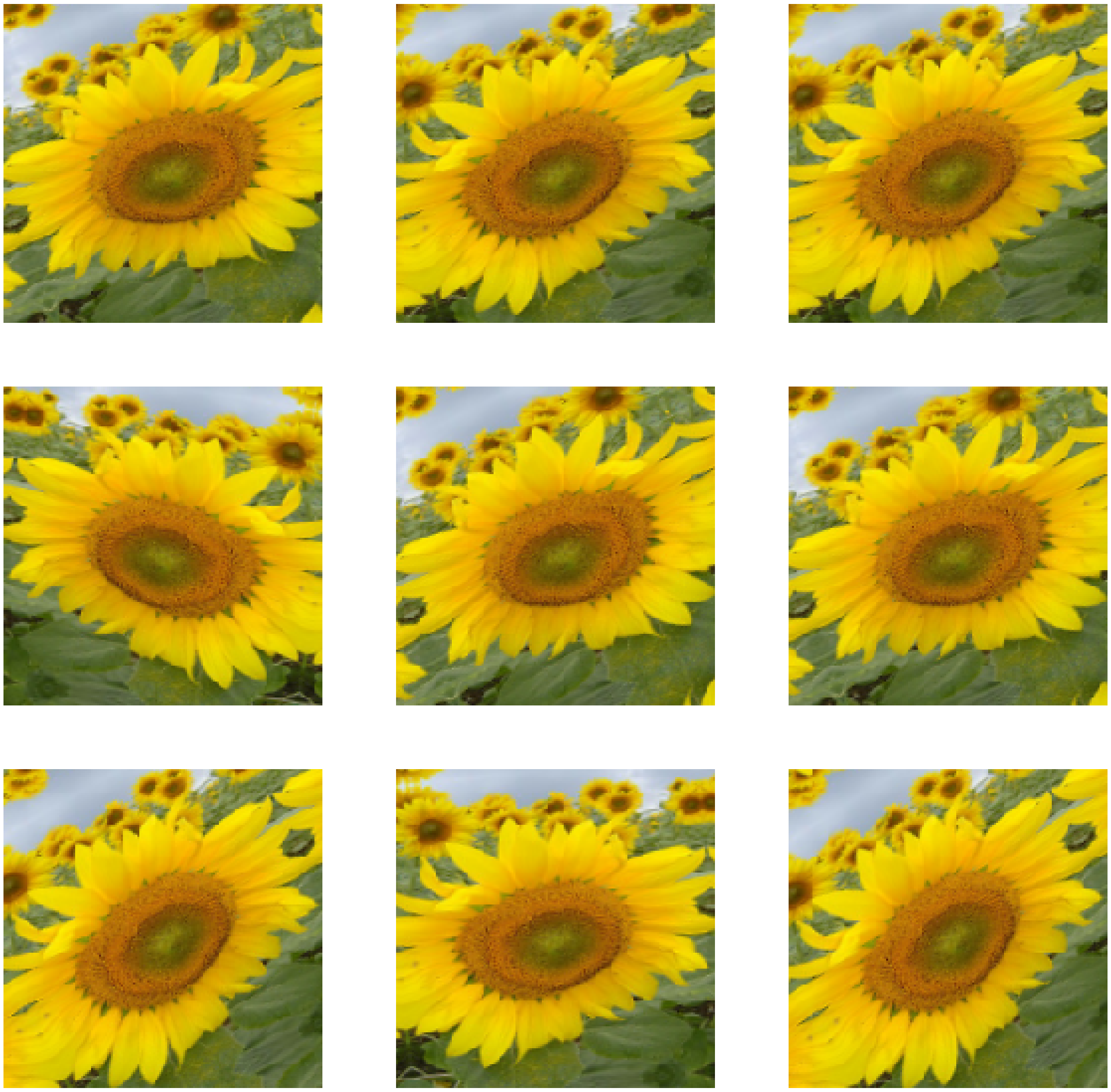
In [7]:

```
# Data augmentation
data_augmentation = keras.Sequential(
    [
        layers.experimental.preprocessing.RandomFlip("horizontal"),
        layers.experimental.preprocessing.RandomRotation(0.1),
    ]
)
```

In [8]:

```
plt.figure(figsize=(10, 10))
for images, _ in train_ds.take(20):
    for i in range(9):
        augmented_images = data_augmentation(images)
        ax = plt.subplot(3, 3, i + 1)
        plt.imshow(augmented_images[0].numpy().astype("uint8"))
        plt.axis("off")
```

```
/Users/becoming1/anaconda3/lib/python3.7/site-packages/matplotlib/figure.
py:98: MatplotlibDeprecationWarning:
Adding an axes using the same arguments as a previous axes currently reus
es the earlier instance.  In a future version, a new instance will always
be created and returned.  Meanwhile, this warning can be suppressed, and
the future behavior ensured, by passing a unique label to each axes insta
nce.
  "Adding an axes using the same arguments as a previous axes "
```



In [9]:

```
train_ds = train_ds.prefetch(buffer_size=32)
val_ds = val_ds.prefetch(buffer_size=32)

def make_model(input_shape, num_classes):
    inputs = keras.Input(shape=input_shape)
    # Image augmentation block
    x = data_augmentation(inputs)

    # Entry block
    x = layers.experimental.preprocessing.Rescaling(1.0 / 255)(x)
    x = layers.Conv2D(32, 3, strides=2, padding="same")(x)
    x = layers.BatchNormalization()(x)
    x = layers.Activation("relu")(x)

    x = layers.Conv2D(64, 3, padding="same")(x)
    x = layers.BatchNormalization()(x)
    x = layers.Activation("relu")(x)

    previous_block_activation = x  # Set aside residual

    for size in [128, 256, 512, 728]:
        x = layers.Activation("relu")(x)
        x = layers.SeparableConv2D(size, 3, padding="same")(x)
        x = layers.BatchNormalization()(x)

        x = layers.Activation("relu")(x)
        x = layers.SeparableConv2D(size, 3, padding="same")(x)
        x = layers.BatchNormalization()(x)

        x = layers.MaxPooling2D(3, strides=2, padding="same")(x)

        # Project residual
        residual = layers.Conv2D(size, 1, strides=2, padding="same")(
            previous_block_activation
        )
        x = layers.add([x, residual])  # Add back residual
        previous_block_activation = x  # Set aside next residual

    x = layers.SeparableConv2D(1024, 3, padding="same")(x)
    x = layers.BatchNormalization()(x)
    x = layers.Activation("relu")(x)

    x = layers.GlobalAveragePooling2D()(x)
    if num_classes == 2:
        activation = "sigmoid"
        units = 1
    else:
        activation = "softmax"
        units = num_classes

    x = layers.Dropout(0.5)(x)
    outputs = layers.Dense(units, activation=activation)(x)
    return keras.Model(inputs, outputs)


model = make_model(input_shape=image_size + (3,), num_classes= 5 )
```

```
#keras.utils.plot_model(model, show_shapes=True)
model.summary()
```

```
Model: "model"
__________________________________________________________________________
_________________________
Layer (type)                    Output Shape         Param #     Connecte
d to
==========================================================================
=========================
input_1 (InputLayer)            [(None, 180, 180, 3) 0

__________________________________________________________________________
_________________________
sequential (Sequential)         (None, 180, 180, 3)  0           input_1
[0][0]

__________________________________________________________________________
_________________________
rescaling (Rescaling)           (None, 180, 180, 3)  0           sequenti
al[0][0]

__________________________________________________________________________
_________________________
conv2d (Conv2D)                 (None, 90, 90, 32)   896         rescalin
g[0][0]
```

In [10]:

```
# training model
epochs = 10

callbacks = [
    keras.callbacks.ModelCheckpoint("save_at_{epoch}.h5"),
]
model.compile(
    optimizer=keras.optimizers.Adam(1e-3),
    loss="categorical_crossentropy",
    metrics=["accuracy"],
)
model.fit(
    train_ds, epochs=epochs, callbacks=callbacks, validation_data=val_ds,
)
```

```
Epoch 1/10
87/87 [==============================] - 1736s 20s/step - loss: 1.2310 -
accuracy: 0.5262 - val_loss: 1.7119 - val_accuracy: 0.2590

/Users/becoming1/anaconda3/lib/python3.7/site-packages/keras/utils/generi
c_utils.py:497: CustomMaskWarning: Custom mask layers require a config an
d must override get_config. When loading, the custom mask layer must be p
assed to the custom_objects argument.
  category=CustomMaskWarning)

Epoch 2/10
87/87 [==============================] - 9128s 106s/step - loss: 1.0458 -
accuracy: 0.6192 - val_loss: 2.1426 - val_accuracy: 0.2590
Epoch 3/10
87/87 [==============================] - 13258s 154s/step - loss: 0.8870
- accuracy: 0.6749 - val_loss: 2.8376 - val_accuracy: 0.2590
Epoch 4/10
87/87 [==============================] - 9377s 109s/step - loss: 0.8675 -
accuracy: 0.6759 - val_loss: 3.3331 - val_accuracy: 0.2590
Epoch 5/10
87/87 [==============================] - 6151s 71s/step - loss: 0.7958 -
accuracy: 0.7027 - val_loss: 4.0389 - val_accuracy: 0.2590
Epoch 6/10
87/87 [==============================] - 291s 3s/step - loss: 0.7182 - ac
curacy: 0.7302 - val_loss: 2.0828 - val_accuracy: 0.3372
Epoch 7/10
87/87 [==============================] - 287s 3s/step - loss: 0.7069 - ac
curacy: 0.7418 - val_loss: 0.9292 - val_accuracy: 0.6585
Epoch 8/10
87/87 [==============================] - 277s 3s/step - loss: 0.6222 - ac
curacy: 0.7700 - val_loss: 1.9697 - val_accuracy: 0.5210
Epoch 9/10
87/87 [==============================] - 273s 3s/step - loss: 0.6037 - ac
curacy: 0.7740 - val_loss: 1.5280 - val_accuracy: 0.5847
Epoch 10/10
87/87 [==============================] - 296s 3s/step - loss: 0.5640 - ac
curacy: 0.7913 - val_loss: 2.1466 - val_accuracy: 0.4848
```

Out[10]:

```
<keras.callbacks.History at 0x7ff445b355c0>
```

In [ ]:

In [ ]:

In [13]:

```
predicted_labels = []
true_labels =  []
for x, y in test_ds:
    pred= model.predict(x)
    true_labels.append(np.where(y == 1)[1][0])
    predicted_labels.append(np.where(pred == np.amax(pred))[1][0])
```

In [ ]:

In [14]:

```
cm = tf.math.confusion_matrix(labels=true_labels, predictions=predicted_lab
class_labels = ['daisy', 'dandelion', 'rose', 'sunflower', 'tulip']
```

In [ ]:

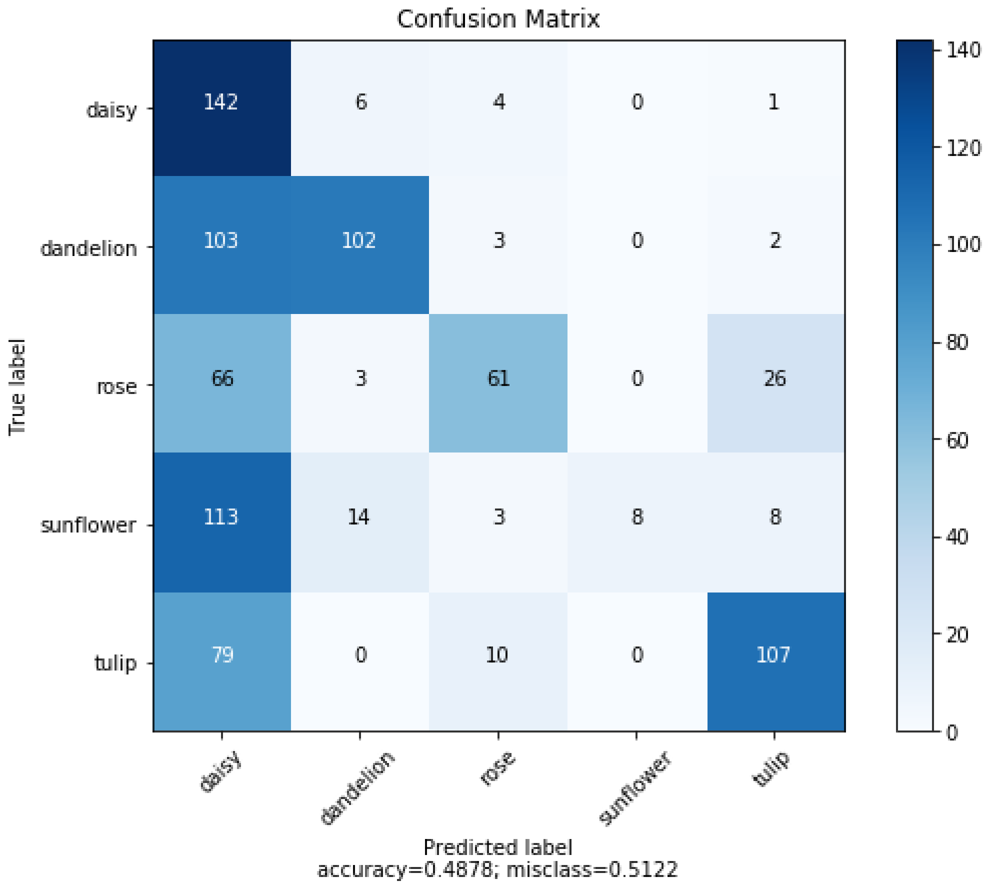
In [ ]:

In [11]:

```
def plot_confusion_matrix(cm,
                          target_names,
                          title='Confusion matrix',
                          cmap=None,
                          normalize=True):

    import matplotlib.pyplot as plt
    import numpy as np
    import itertools

    accuracy = np.trace(cm) / float(np.sum(cm))
    misclass = 1 - accuracy

    if cmap is None:
        cmap = plt.get_cmap('Blues')

    plt.figure(figsize=(8, 6))
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()

    if target_names is not None:
        tick_marks = np.arange(len(target_names))
        plt.xticks(tick_marks, target_names, rotation=45)
        plt.yticks(tick_marks, target_names)

    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]


    thresh = cm.max() / 1.5 if normalize else cm.max() / 2
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        if normalize:
            plt.text(j, i, "{:0.4f}".format(cm[i, j]),
                     horizontalalignment="center",
                     color="white" if cm[i, j] > thresh else "black")
        else:
            plt.text(j, i, "{:,}".format(cm[i, j]),
                     horizontalalignment="center",
                     color="white" if cm[i, j] > thresh else "black")


    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label\naccuracy={:0.4f}; misclass={:0.4f}'.format
    plt.show()
```

In [15]:

```
# confusion matrix
# It seems my model predicted fairly bad because it seems 10 epoc
# is not enough to train my model, on the other hand training 20 epoc
# takes very long
plot_confusion_matrix(cm,
                      normalize    = False,
                      target_names = class_labels,
                      title        = "Confusion Matrix")
```



True label \ Predicted label	daisy	dandelion	rose	sunflower	tulip
daisy	142	6	4	0	1
dandelion	103	102	3	0	2
rose	66	3	61	0	26
sunflower	113	14	3	8	8
tulip	79	0	10	0	107

accuracy=0.4878; misclass=0.5122

In [ ]:

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In [ ]: