Andrew Vu - CS156_HW8

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1 CS156 (Introduction to AI), Spring 2022

2 Homework 8 submission

2.0.1 Roster Name: Andrew Vu

2.0.2 Student ID: 015055911

2.0.3 Email address: andrew.k.vu@sjsu.edu

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

2.1 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. - CNN.Dog_vs_cat_images from your examples - https://www.kaggle.com/grfiv4/plot-a-confusion-matrix - https://stackoverflow.com/questions/64687375/get-labels-from-dataset-when-using-tensorflow-image-dataset-from-directory

2.2 Solution

Load libraries and set random number generator seed

[103]:
```
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers
import os
import matplotlib.pyplot as plt
# import pydot
from skimage import io
import numpy as np
import itertools
```

[104]:
```
np.random.seed(42)
```

Code the solution

2.2.1 Loading Dataset Images

[105]:
```
image_size = (180, 180)
batch_size = 32

print("Training data: ")
train_ds = tf.keras.preprocessing.image_dataset_from_directory(
    "./hw8useful/homework8_input_data/flowers/training",
    labels='inferred',
    label_mode='categorical',
    validation_split=0.2,
    subset="training",
    seed=42,
    image_size=image_size,
    batch_size=batch_size,
)

print("\nValidation data: ")
val_ds = tf.keras.preprocessing.image_dataset_from_directory(
    "./hw8useful/homework8_input_data/flowers/training",
    labels='inferred',
    label_mode='categorical',
    validation_split=0.2,
    subset="validation",
    seed=42,
    image_size=image_size,
    batch_size=batch_size,
)

print("\nTest data: ")
test_ds = tf.keras.preprocessing.image_dataset_from_directory(
    "./hw8useful/homework8_input_data/flowers/test",
    labels='inferred',
    label_mode='categorical',
    seed=42,
    image_size=image_size,
    batch_size=1,
)
```

```
Training data:
Found 3456 files belonging to 5 classes.
Using 2765 files for training.

Validation data:
Found 3456 files belonging to 5 classes.
Using 691 files for validation.

Test data:
```

```
Found 861 files belonging to 5 classes.
```

2.2.2 Augment the data

[106]:
```python
data_augmentation = keras.Sequential(
    [
        layers.experimental.preprocessing.RandomFlip("horizontal"),
        layers.experimental.preprocessing.RandomRotation(0.1),
    ]
)
```

2.2.3 Define model architecture

[107]:
```python
# FROM CNN.Dog_vs_cat_images file
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 == 5:
        activation = "sigmoid"
        units = 5
    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_9"
________________________________________________________________________________
__________________
 Layer (type)                   Output Shape         Param #     Connected to
================================================================================
==================
 input_10 (InputLayer)          [(None, 180, 180, 3  0           []
                                )]

 sequential_9 (Sequential)      (None, 180, 180, 3)  0
['input_10[0][0]']

 rescaling_9 (Rescaling)        (None, 180, 180, 3)  0
['sequential_9[0][0]']

 conv2d_54 (Conv2D)             (None, 90, 90, 32)   896
['rescaling_9[0][0]']

 batch_normalization_99 (BatchN  (None, 90, 90, 32)  128
['conv2d_54[0][0]']
 ormalization)
```

```
 activation_99 (Activation)     (None, 90, 90, 32)   0
['batch_normalization_99[0][0]']

 conv2d_55 (Conv2D)             (None, 90, 90, 64)   18496
['activation_99[0][0]']

 batch_normalization_100 (Batch  (None, 90, 90, 64)  256
['conv2d_55[0][0]']
 Normalization)

 activation_100 (Activation)    (None, 90, 90, 64)   0
['batch_normalization_100[0][0]']

 activation_101 (Activation)    (None, 90, 90, 64)   0
['activation_100[0][0]']

 separable_conv2d_81 (Separable  (None, 90, 90, 128)  8896
['activation_101[0][0]']
 Conv2D)

 batch_normalization_101 (Batch  (None, 90, 90, 128)  512
['separable_conv2d_81[0][0]']
 Normalization)

 activation_102 (Activation)    (None, 90, 90, 128)  0
['batch_normalization_101[0][0]']

 separable_conv2d_82 (Separable  (None, 90, 90, 128)  17664
['activation_102[0][0]']
 Conv2D)

 batch_normalization_102 (Batch  (None, 90, 90, 128)  512
['separable_conv2d_82[0][0]']
 Normalization)

 max_pooling2d_36 (MaxPooling2D  (None, 45, 45, 128)  0
['batch_normalization_102[0][0]']
 )

 conv2d_56 (Conv2D)             (None, 45, 45, 128)  8320
['activation_100[0][0]']

 add_36 (Add)                   (None, 45, 45, 128)  0
['max_pooling2d_36[0][0]',
'conv2d_56[0][0]']

 activation_103 (Activation)    (None, 45, 45, 128)  0
['add_36[0][0]']
```

```
 separable_conv2d_83 (Separable  (None, 45, 45, 256)  34176
['activation_103[0][0]']
 Conv2D)

 batch_normalization_103 (Batch  (None, 45, 45, 256)  1024
['separable_conv2d_83[0][0]']
 Normalization)

 activation_104 (Activation)    (None, 45, 45, 256)  0
['batch_normalization_103[0][0]']

 separable_conv2d_84 (Separable  (None, 45, 45, 256)  68096
['activation_104[0][0]']
 Conv2D)

 batch_normalization_104 (Batch  (None, 45, 45, 256)  1024
['separable_conv2d_84[0][0]']
 Normalization)

 max_pooling2d_37 (MaxPooling2D  (None, 23, 23, 256)  0
['batch_normalization_104[0][0]']
 )

 conv2d_57 (Conv2D)             (None, 23, 23, 256)  33024
['add_36[0][0]']

 add_37 (Add)                   (None, 23, 23, 256)  0
['max_pooling2d_37[0][0]',
'conv2d_57[0][0]']

 activation_105 (Activation)    (None, 23, 23, 256)  0
['add_37[0][0]']

 separable_conv2d_85 (Separable  (None, 23, 23, 512)  133888
['activation_105[0][0]']
 Conv2D)

 batch_normalization_105 (Batch  (None, 23, 23, 512)  2048
['separable_conv2d_85[0][0]']
 Normalization)

 activation_106 (Activation)    (None, 23, 23, 512)  0
['batch_normalization_105[0][0]']

 separable_conv2d_86 (Separable  (None, 23, 23, 512)  267264
['activation_106[0][0]']
 Conv2D)
```

```
 batch_normalization_106 (Batch  (None, 23, 23, 512)  2048
['separable_conv2d_86[0][0]']
 Normalization)

 max_pooling2d_38 (MaxPooling2D  (None, 12, 12, 512)  0
['batch_normalization_106[0][0]']
 )

 conv2d_58 (Conv2D)             (None, 12, 12, 512)  131584
['add_37[0][0]']

 add_38 (Add)                   (None, 12, 12, 512)  0
['max_pooling2d_38[0][0]',
'conv2d_58[0][0]']

 activation_107 (Activation)    (None, 12, 12, 512)  0
['add_38[0][0]']

 separable_conv2d_87 (Separable  (None, 12, 12, 728)  378072
['activation_107[0][0]']
 Conv2D)

 batch_normalization_107 (Batch  (None, 12, 12, 728)  2912
['separable_conv2d_87[0][0]']
 Normalization)

 activation_108 (Activation)    (None, 12, 12, 728)  0
['batch_normalization_107[0][0]']

 separable_conv2d_88 (Separable  (None, 12, 12, 728)  537264
['activation_108[0][0]']
 Conv2D)

 batch_normalization_108 (Batch  (None, 12, 12, 728)  2912
['separable_conv2d_88[0][0]']
 Normalization)

 max_pooling2d_39 (MaxPooling2D  (None, 6, 6, 728)   0
['batch_normalization_108[0][0]']
 )

 conv2d_59 (Conv2D)             (None, 6, 6, 728)    373464
['add_38[0][0]']

 add_39 (Add)                   (None, 6, 6, 728)    0
['max_pooling2d_39[0][0]',
'conv2d_59[0][0]']
```

```
 separable_conv2d_89 (Separable  (None, 6, 6, 1024)  753048
['add_39[0][0]']
 Conv2D)

 batch_normalization_109 (Batch  (None, 6, 6, 1024)  4096
['separable_conv2d_89[0][0]']
 Normalization)

 activation_109 (Activation)    (None, 6, 6, 1024)   0
['batch_normalization_109[0][0]']

 global_average_pooling2d_9 (Gl  (None, 1024)        0
['activation_109[0][0]']
 obalAveragePooling2D)

 dropout_9 (Dropout)            (None, 1024)         0
['global_average_pooling2d_9[0][0
                                                                ]']

 dense_9 (Dense)                (None, 5)            5125
['dropout_9[0][0]']

================================================================================
==================
Total params: 2,786,749
Trainable params: 2,778,013
Non-trainable params: 8,736
--------------------------------------------------------------------------------
------------------
```

2.2.4 Train the model

[108]:
```python
epochs = 20

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 1/20
```

```
87/87 [==============================] - 196s 2s/step - loss: 1.2704 - accuracy:
0.5266 - val_loss: 1.6723 - val_accuracy: 0.2590
Epoch 2/20
87/87 [==============================] - 194s 2s/step - loss: 0.9803 - accuracy:
0.6347 - val_loss: 2.0438 - val_accuracy: 0.2590
Epoch 3/20
87/87 [==============================] - 194s 2s/step - loss: 0.8981 - accuracy:
0.6665 - val_loss: 2.8017 - val_accuracy: 0.2590
Epoch 4/20
87/87 [==============================] - 194s 2s/step - loss: 0.8464 - accuracy:
0.6828 - val_loss: 3.5591 - val_accuracy: 0.2590
Epoch 5/20
87/87 [==============================] - 194s 2s/step - loss: 0.7598 - accuracy:
0.7251 - val_loss: 4.0505 - val_accuracy: 0.2590
Epoch 6/20
87/87 [==============================] - 195s 2s/step - loss: 0.7648 - accuracy:
0.7175 - val_loss: 1.9164 - val_accuracy: 0.3184
Epoch 7/20
87/87 [==============================] - 195s 2s/step - loss: 0.6780 - accuracy:
0.7432 - val_loss: 1.6610 - val_accuracy: 0.5109
Epoch 8/20
87/87 [==============================] - 195s 2s/step - loss: 0.6393 - accuracy:
0.7609 - val_loss: 0.9687 - val_accuracy: 0.6744
Epoch 9/20
87/87 [==============================] - 194s 2s/step - loss: 0.6598 - accuracy:
0.7577 - val_loss: 1.3565 - val_accuracy: 0.6107
Epoch 10/20
87/87 [==============================] - 194s 2s/step - loss: 0.5747 - accuracy:
0.7855 - val_loss: 0.9174 - val_accuracy: 0.7091
Epoch 11/20
87/87 [==============================] - 195s 2s/step - loss: 0.5501 - accuracy:
0.7953 - val_loss: 2.0934 - val_accuracy: 0.4891
Epoch 12/20
87/87 [==============================] - 195s 2s/step - loss: 0.5193 - accuracy:
0.8072 - val_loss: 2.0853 - val_accuracy: 0.5384
Epoch 13/20
87/87 [==============================] - 194s 2s/step - loss: 0.5087 - accuracy:
0.8134 - val_loss: 0.9619 - val_accuracy: 0.6816
Epoch 14/20
87/87 [==============================] - 194s 2s/step - loss: 0.4853 - accuracy:
0.8235 - val_loss: 0.8468 - val_accuracy: 0.7525
Epoch 15/20
87/87 [==============================] - 194s 2s/step - loss: 0.4649 - accuracy:
0.8239 - val_loss: 1.3818 - val_accuracy: 0.6382
Epoch 16/20
87/87 [==============================] - 194s 2s/step - loss: 0.4863 - accuracy:
0.8170 - val_loss: 0.6505 - val_accuracy: 0.7713
Epoch 17/20
```

```
87/87 [==============================] - 194s 2s/step - loss: 0.4223 - accuracy:
0.8456 - val_loss: 0.6533 - val_accuracy: 0.7728
Epoch 18/20
87/87 [==============================] - 194s 2s/step - loss: 0.4191 - accuracy:
0.8506 - val_loss: 1.1794 - val_accuracy: 0.6932
Epoch 19/20
87/87 [==============================] - 194s 2s/step - loss: 0.4378 - accuracy:
0.8347 - val_loss: 0.8742 - val_accuracy: 0.7598
Epoch 20/20
87/87 [==============================] - 194s 2s/step - loss: 0.3836 - accuracy:
0.8586 - val_loss: 0.5915 - val_accuracy: 0.7988
```

[108]:
```
<keras.callbacks.History at 0x297839a7850>
```

2.2.5 Evaluate the model

[109]:
```python
score = model.evaluate(test_ds)
print("Test loss:", score[0])
print("Test accuracy:", score[1])
```

```
861/861 [==============================] - 20s 23ms/step - loss: 0.9867 -
accuracy: 0.6864
Test loss: 0.9867478609085083
Test accuracy: 0.6864111423492432
```

2.2.6 Going through test data imageset

[110]:
```python
predicted_labels = np.array([])
true_labels = np.array([])
label_names = ['daisy', 'dandelion', 'rose', 'sunflower', 'tulip']

for x, y in test_ds:
    predicted_labels = np.concatenate([predicted_labels, np.argmax(model.
 ↪predict(x), axis = -1)])
    true_labels = np.concatenate([true_labels, np.argmax(y.numpy(), axis=-1)])

cm = tf.math.confusion_matrix(labels=true_labels, predictions=predicted_labels).
 ↪numpy()
print(cm)
```

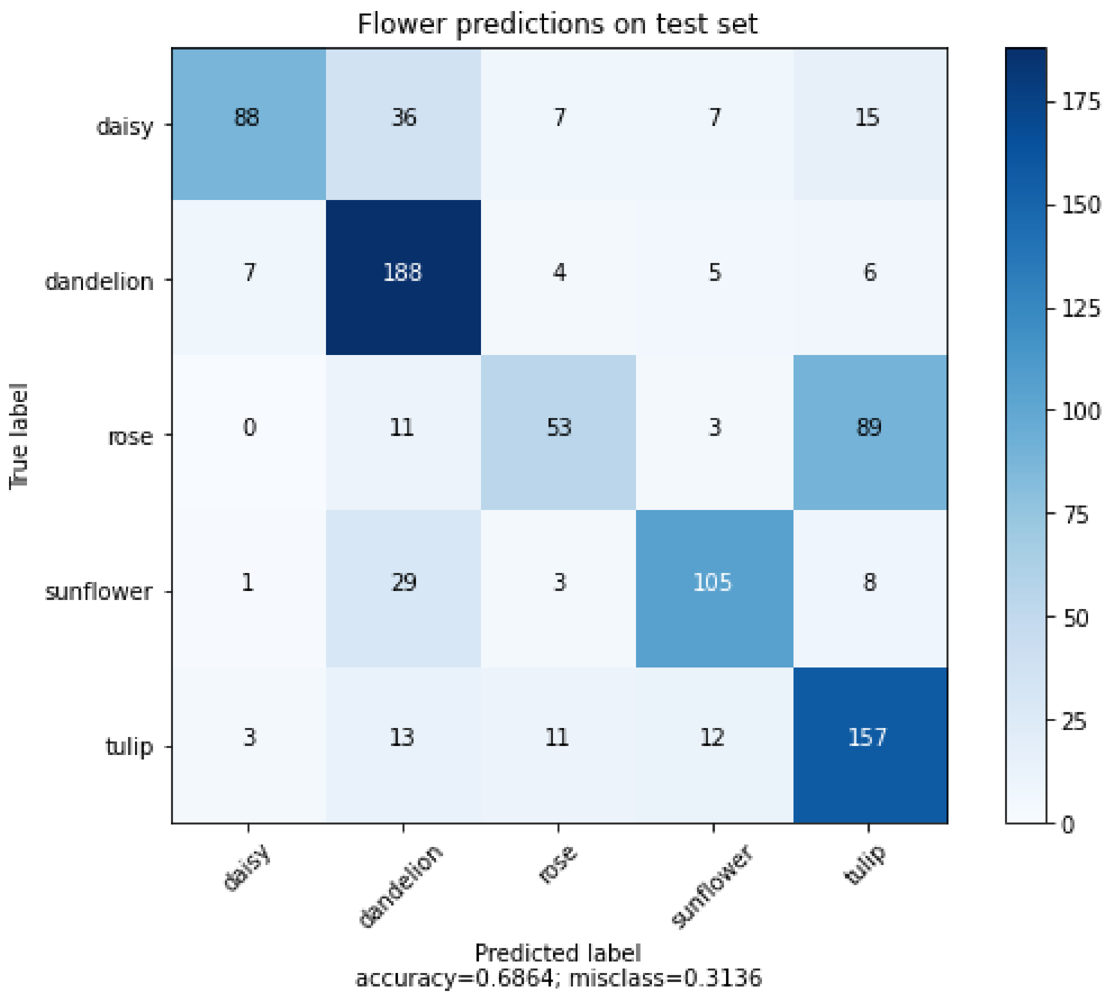
```
[[ 88  36   7   7  15]
 [  7 188   4   5   6]
 [  0  11  53   3  89]
 [  1  29   3 105   8]
 [  3  13  11  12 157]]
```

2.2.7 Plotting confusion matrix

[111]:
```
def plot_confusion_matrix(cm,
                          target_names,
                          title='Confusion matrix',
                          cmap=None,
                          normalize=True):
    """
    given a sklearn confusion matrix (cm), make a nice plot

    Arguments
    ---------
    cm:           confusion matrix from sklearn.metrics.confusion_matrix

    target_names: given classification classes such as [0, 1, 2]
                  the class names, for example: ['high', 'medium', 'low']

    title:        the text to display at the top of the matrix

    cmap:         the gradient of the values displayed from matplotlib.pyplot.cm
                  see http://matplotlib.org/examples/color/colormaps_reference.
↪html
                  plt.get_cmap('jet') or plt.cm.Blues

    normalize:    If False, plot the raw numbers
                  If True, plot the proportions

    Usage
    -----
    plot_confusion_matrix(cm           = cm,                  # confusion␣
↪matrix created by
                                                              # sklearn.metrics.
↪confusion_matrix
                          normalize    = True,                # show proportions
                          target_names = y_labels_vals,       # list of names␣
↪of the classes
                          title        = best_estimator_name) # title of graph

    Citiation
    ---------
    http://scikit-learn.org/stable/auto_examples/model_selection/
↪plot_confusion_matrix.html

    """


    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(accuracy, misclass))
    plt.show()
```

[112]:
```
plot_confusion_matrix(cm = cm,
                      normalize = False,
                      target_names = label_names,
                      title = 'Flower predictions on test set')
```



[113]:
```python
print(predicted_labels)
print(true_labels)
print(len(predicted_labels))
```

```
[4. 3. 1. 0. 1. 1. 3. 3. 1. 1. 1. 2. 1. 2. 3. 1. 1. 1. 4. 4. 4. 1. 4. 4.
 4. 2. 3. 1. 4. 1. 0. 1. 0. 4. 3. 4. 1. 0. 1. 1. 1. 2. 4. 1. 2. 3. 4. 3.
 2. 3. 4. 1. 1. 4. 3. 4. 0. 1. 1. 2. 1. 0. 2. 1. 4. 4. 1. 4. 3. 4. 1. 4.
 4. 3. 1. 3. 3. 4. 4. 0. 4. 1. 4. 1. 3. 1. 1. 3. 1. 0. 3. 3. 4. 3. 4. 4.
 4. 4. 4. 3. 1. 3. 4. 0. 3. 1. 3. 4. 0. 4. 0. 1. 1. 1. 1. 1. 3. 4. 4. 4.
 4. 3. 0. 1. 4. 4. 1. 4. 2. 1. 2. 4. 1. 4. 3. 4. 2. 0. 4. 4. 0. 0. 1. 4.
 0. 1. 3. 1. 1. 2. 3. 0. 1. 1. 0. 4. 4. 4. 1. 1. 3. 2. 1. 1. 0. 4. 0. 2.
 1. 1. 3. 1. 1. 1. 2. 4. 4. 4. 0. 1. 2. 2. 3. 1. 4. 1. 1. 4. 3. 3. 3. 4.
 4. 0. 4. 1. 2. 4. 0. 4. 4. 1. 1. 4. 3. 1. 4. 4. 3. 2. 4. 3. 4. 3. 0. 0.
 4. 4. 1. 1. 1. 2. 4. 4. 0. 3. 0. 3. 1. 2. 4. 3. 4. 1. 3. 4. 2. 4. 1. 1.
 1. 3. 4. 0. 4. 4. 4. 0. 3. 4. 1. 0. 1. 0. 3. 1. 4. 4. 4. 4. 1. 1. 0. 1.
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```

```
 2. 4. 2. 3. 4. 3. 1. 1. 4. 1. 3. 3. 1. 3. 3. 4. 3. 4. 1. 1. 1. 0. 4. 1.
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 3. 3. 4. 4. 1. 2. 1. 1. 4. 1. 4. 1. 3. 4. 4. 4. 1. 0. 2. 0. 4. 4. 1. 3.
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 3. 4. 4. 4. 3. 2. 1. 3. 0. 1. 1. 0. 4. 4. 1. 4. 1. 4. 1. 1. 4. 4. 4. 4.
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```

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 1. 0. 2. 2. 3. 0. 1. 0. 2. 2. 3. 1. 1. 0. 4. 0. 1. 0. 0. 2. 0.]
861
```

2.2.8 Examples of misclassified images

[118]:
```python
url = './hw8useful/homework8_input_data/flowers/test/daisy/
 ↪34508227161_a9ff840f71_n.jpg'

img = io.imread(url)
plt.figure(figsize=(8, 5))
plt.axis("off")
plt.title("daisy predicted as dandelion")
plt.imshow(img)

# label_names = ['daisy', 'dandelion', 'rose', 'sunflower', 'tulip']
img = keras.preprocessing.image.load_img(
    url, target_size=image_size
)
img_array = keras.preprocessing.image.img_to_array(img)
img_array = tf.expand_dims(img_array, 0)  # Create batch axis

predictions = model.predict(img_array)
score = predictions[0]
# print(
#     "This image is %.2f percent cat and %.2f percent dog."
#     % (100 * (1 - score), 100 * score)
# )
print('daisy: ' + str(score[0] * 100),
      'dandelion: ' + str(score[1] * 100),
      'rose: ' + str(score[2] * 100),
      'sunflower: ' + str(score[3] * 100),
      'tulip: ' + str(score[4] * 100))
```

```
daisy: 4.419979453086853 dandelion: 99.74010586738586 rose: 6.566828489303589
sunflower: 57.685184478759766 tulip: 19.940277934074402
```

daisy predicted as dandelion

[115]:
```
url = './hw8useful/homework8_input_data/flowers/test/rose/
 ↪17105684129_e2cb69ea24_n.jpg'

img = io.imread(url)
plt.figure(figsize=(8, 5))
plt.axis("off")
plt.title("rose predicted as dandelion")
plt.imshow(img)

# label_names = ['daisy', 'dandelion', 'rose', 'sunflower', 'tulip']
img = keras.preprocessing.image.load_img(
    url, target_size=image_size
)
img_array = keras.preprocessing.image.img_to_array(img)
img_array = tf.expand_dims(img_array, 0)  # Create batch axis

predictions = model.predict(img_array)
score = predictions[0]
# print(
#     "This image is %.2f percent cat and %.2f percent dog."
#     % (100 * (1 - score), 100 * score)
```

```
# )
print('daisy: ' + str(score[0] * 100),
      'dandelion: ' + str(score[1] * 100),
      'rose: ' + str(score[2] * 100),
      'sunflower: ' + str(score[3] * 100),
      'tulip: ' + str(score[4] * 100))
```

```
daisy: 26.46360993385315 dandelion: 78.54951620101929 rose: 62.350279092788696
sunflower: 5.901333689689636 tulip: 71.77703380584717
```

rose predicted as dandelion

[125]:

```
url = './hw8useful/homework8_input_data/flowers/test/sunflower/
 ↪21899501660_7065d1c1fa_n.jpg'

img = io.imread(url)
plt.figure(figsize=(8, 5))
plt.axis("off")
plt.title("sunflower predicted as dandelion")
plt.imshow(img)

# label_names = ['daisy', 'dandelion', 'rose', 'sunflower', 'tulip']
img = keras.preprocessing.image.load_img(
    url, target_size=image_size
```

```python
)
img_array = keras.preprocessing.image.img_to_array(img)
img_array = tf.expand_dims(img_array, 0)  # Create batch axis

predictions = model.predict(img_array)
score = predictions[0]
# print(
#     "This image is %.2f percent cat and %.2f percent dog."
#     % (100 * (1 - score), 100 * score)
# )
print('daisy: ' + str(score[0] * 100),
      'dandelion: ' + str(score[1] * 100),
      'rose: ' + str(score[2] * 100),
      'sunflower: ' + str(score[3] * 100),
      'tulip: ' + str(score[4] * 100))
```

```
daisy: 28.46115231513977 dandelion: 77.77357697486877 rose: 26.94074511528015
sunflower: 31.566447019577026 tulip: 61.55676245689392
```


```
[ ]:
```