Accuracy and Misclassification

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0.1 # 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'd like 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).

0.1.1 Import resources

Before you get started on the project code, import the libraries and resources that you'll need.

```
In [1]: import cv2 # computer vision library
        import helpers

        import numpy as np
        import matplotlib.pyplot as plt
        import matplotlib.image as mpimg

        %matplotlib inline
```

0.2 Training and Testing Data

The 200 day/night images are separated into training and testing datasets.

- 60% of these images are training images, for you to use as you create a classifier.
- 40% are test images, which will be used to test the accuracy of your classifier.

First, we set some variables to keep track of some where our images are stored:

```
image_dir_training: the directory where our training image data is stored
image_dir_test: the directory where our test image data is stored
```

```
In [2]: # Image data directories
        image_dir_training = "day_night_images/training/"
        image_dir_test = "day_night_images/test/"
```

0.3 Load the datasets

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][:]`.

```
In [3]: # Using the load_dataset function in helpers.py
        # Load training data
        IMAGE_LIST = helpers.load_dataset(image_dir_training)
```

0.4 Construct a `STANDARDIZED_LIST` of input images and output labels.

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

```
In [4]: # Standardize all training images
        STANDARDIZED_LIST = helpers.standardize(IMAGE_LIST)
```

0.5 Visualize the standardized data

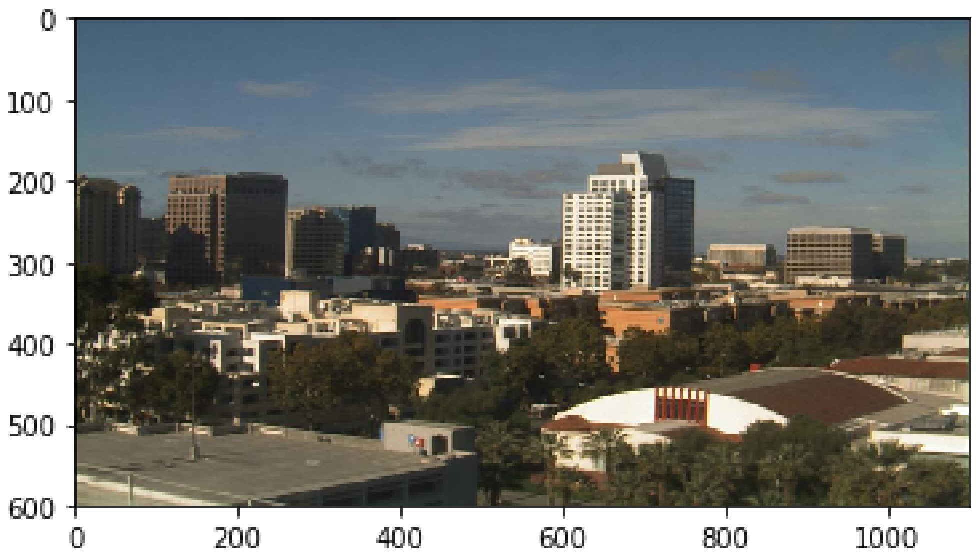
Display a standardized image from STANDARDIZED_LIST.

```
In [5]: # Display a standardized image and its label

        # Select an image by index
        image_num = 0
        selected_image = STANDARDIZED_LIST[image_num][0]
        selected_label = STANDARDIZED_LIST[image_num][1]

        # Display image and data about it
        plt.imshow(selected_image)
        print("Shape: "+str(selected_image.shape))
        print("Label [1 = day, 0 = night]: " + str(selected_label))
```

```
Shape: (600, 1100, 3)
Label [1 = day, 0 = night]: 1
```



1 Feature Extraction

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.

1.0.1 Find the average brightness using the V channel

This function takes in a **standardized** RGB image and returns a feature (a single value) that represent the average level of brightness in the image. We'll use this value to classify the image as day or night.

```
In [6]: # Find the average Value or brightness of an image
        def avg_brightness(rgb_image):
            # Convert image to HSV
            hsv = cv2.cvtColor(rgb_image, cv2.COLOR_RGB2HSV)

            # Add up all the pixel values in the V channel
            sum_brightness = np.sum(hsv[:,:,2])
            area = 600*1100.0  # pixels

            # find the avg
            avg = sum_brightness/area

            return avg
```

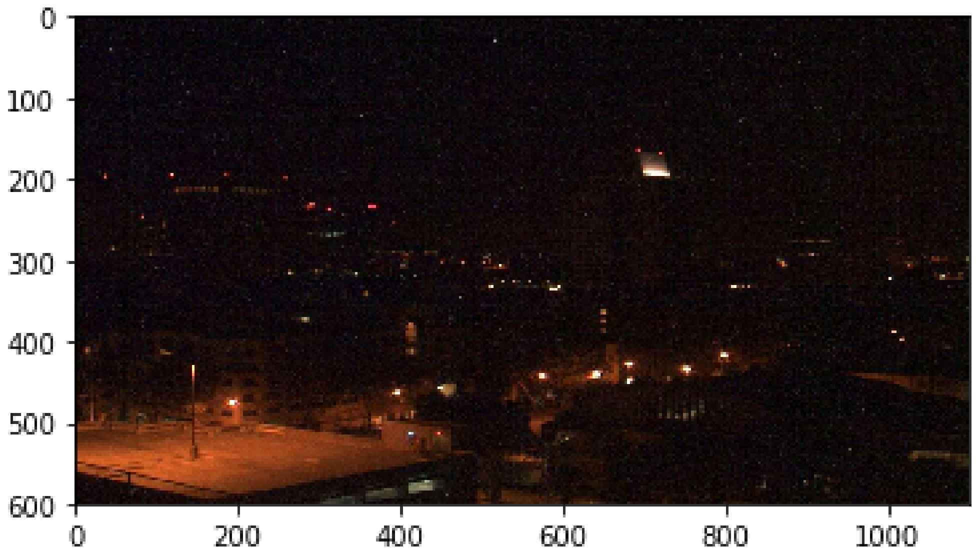
```
In [7]: # Testing average brightness levels
        # Look at a number of different day and night images and think about
        # what average brightness value separates the two types of images

        # As an example, a "night" image is loaded in and its avg brightness is displayed
        image_num = 190
        test_im = STANDARDIZED_LIST[image_num][0]

        avg = avg_brightness(test_im)
        print('Avg brightness: ' + str(avg))
        plt.imshow(test_im)
```

```
Avg brightness: 25.677469697
```

```
Out[7]: <matplotlib.image.AxesImage at 0x7f7d8d67e438>
```



2 Classification and Visualizing Error

In this section, 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).

2.0.1 TODO: Build a complete classifier

Complete this code so that it returns an estimated class label given an input RGB image.

```
In [47]: # This function should take in RGB image input
         def estimate_label(rgb_image):

             # TO-DO: Extract average brightness feature from an RGB image
             avg = avg_brightness(rgb_image)

             # Use the avg brightness feature to predict a label (0, 1)
             predicted_label = 0
             # TO-DO: Try out different threshold values to see what works best!
             threshold = 99
             if(avg > threshold):
                 # if the average brightness is above the threshold value, we classify it as "da
                 predicted_label = 1
             # else, the predicted_label can stay 0 (it is predicted to be "night")

             return predicted_label
```

2.1 Testing the classifier

Here is where we test your classification algorithm using our test set of data that we set aside at the beginning of the notebook!

Since we are using a pretty simple brightess feature, we may not expect this classifier to be 100% accurate. We'll aim for around 75-85% accuracy usin this one feature.

2.1.1 Test dataset

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.

```
In [24]: import random

         # Using the load_dataset function in helpers.py
         # Load test data
         TEST_IMAGE_LIST = helpers.load_dataset(image_dir_test)

         # Standardize the test data
         STANDARDIZED_TEST_LIST = helpers.standardize(TEST_IMAGE_LIST)

         # Shuffle the standardized test data
         random.shuffle(STANDARDIZED_TEST_LIST)
```

2.2 Determine the Accuracy

Compare the output of your classification algorithm (a.k.a. your "model") with the true labels and determine the accuracy.

This code stores all the misclassified images, their predicted labels, and their true labels, in a list called `misclassified`.

```
In [45]: # Constructs a list of misclassified images given a list of test images and their label
         def get_misclassified_images(test_images):
             # Track misclassified images by placing them into a list
             misclassified_images_labels = []

             # Iterate through all the test images
             # Classify each image and compare to the true label
             for image in test_images:

                 # Get true data
                 im = image[0]
                 true_label = image[1]

                 # Get predicted label from your classifier
                 predicted_label = estimate_label(im)

                 # Compare true and predicted labels
                 if(predicted_label != true_label):
                     # If these labels are not equal, the image has been misclassified
                     misclassified_images_labels.append((im, predicted_label, true_label))

             # Return the list of misclassified [image, predicted_label, true_label] values
             return misclassified_images_labels
```

```
In [48]: # Find all misclassified images in a given test set
         MISCLASSIFIED = get_misclassified_images(STANDARDIZED_TEST_LIST)

         # Accuracy calculations
         total = len(STANDARDIZED_TEST_LIST)
         num_correct = total - len(MISCLASSIFIED)
         accuracy = num_correct/total

         print('Accuracy: ' + str(accuracy))
         print("Number of misclassified images = " + str(len(MISCLASSIFIED)) +' out of '+ str(to
```

```
Accuracy: 0.9375
Number of misclassified images = 10 out of 160
```

### TO-DO: Visualize the misclassified images
Visualize some of the images you classified wrong (in the `MISCLASSIFIED` list) and note any qualities that make them difficult to classify. This will help you identify any weaknesses in your classification algorithm.

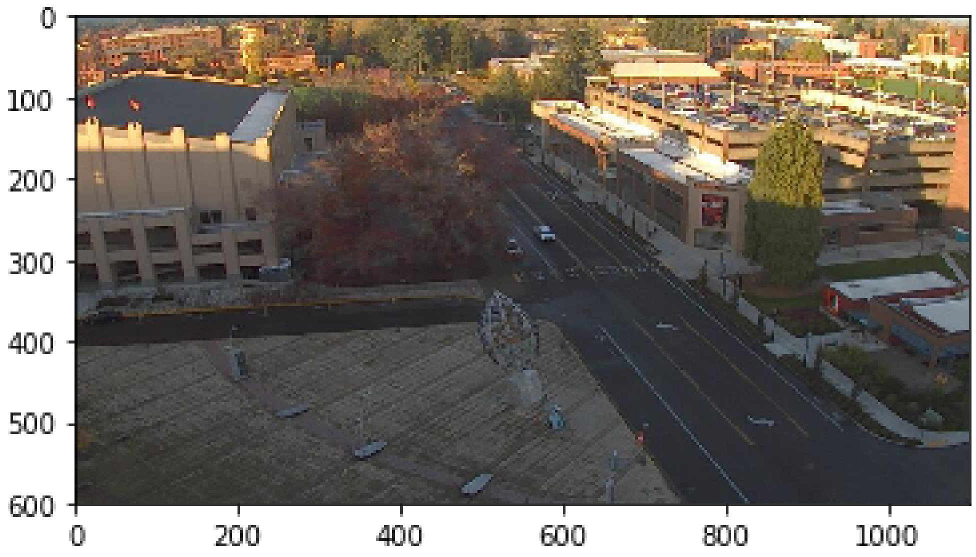
```
In [59]: # Visualize misclassified example(s)

         test_mis_im = MISCLASSIFIED[0][0]
```

```
        test_mis_label = MISCLASSIFIED[0][1]

        ## TODO: Display an image in the `MISCLASSIFIED` list
        ## TODO: Print out its predicted label -
        ## to see what the image *was* incorrectly classified as
        plt.imshow(test_mis_im)
        print("predicted label",test_mis_label)
```

```
predicted label 0
```



```
In [ ]:
```