

# Programming Assignment 1 : Data Preparation and Understanding

```
import os
import xml.etree.ElementTree as ET
import numpy as np
import matplotlib.pyplot as plt
from skimage import io, color, exposure, filters
from sklearn.decomposition import PCA
from skimage.feature import hog
from skimage.transform import resize
from skimage import img_as_ubyte

from google.colab import drive
drive.mount('/content/drive')
# Main execution
dog_images_folder = '/content/drive/MyDrive/mulinti_images'
annotations_folder = '/content/drive/MyDrive/mulinti_annotation'

Mounted at /content/drive

dog_images = {}
annotations = {}

# Load images and annotations
for folder_name in os.listdir(dog_images_folder):
    folder_path = os.path.join(dog_images_folder, folder_name)
    image_paths = [os.path.join(folder_path, img) for img in
os.listdir(folder_path)]
    dog_images[folder_name] = image_paths

for folder_name in os.listdir(annotations_folder):
    folder_path = os.path.join(annotations_folder, folder_name)
    annotation_paths = [os.path.join(folder_path, annot) for annot in
os.listdir(folder_path)]
    annotations[folder_name] = annotation_paths
```

## Q 2a: Cropping and Resize Images in Your 4-class Images Dataset

Use the bounding box information in the Annotations dataset relevant to your 4-class Images Dataset to crop the images in your dataset and then resize each image to a 128×128 pixel image.

```
import xml.etree.ElementTree as ET

def get_bounding_boxes(xml_path):
    tree = ET.parse(xml_path)
    root = tree.getroot()
```

```

bounding_boxes = []

for obj in root.findall('object'):
    bbox = obj.find('bndbox')

    xmin, ymin, xmax, ymax = map(int, (bbox.find('xmin').text,
                                         bbox.find('ymin').text,
                                         bbox.find('xmax').text,
                                         bbox.find('ymax').text))

    bounding_boxes.append((xmin, ymin, xmax, ymax))

return bounding_boxes

import os
from skimage import io, transform, img_as_ubyte

def process_images(image_paths, annotation_paths):
    """Crop and resize images based on bounding box annotations."""
    for i in range(len(image_paths)):
        bounding_boxes = get_bounding_boxes(annotation_paths[i])

        original_image = io.imread(image_paths[i])

        for j, bbox in enumerate(bounding_boxes):
            cropped_image = original_image[bbox[1]:bbox[3],
            bbox[0]:bbox[2]]

            if cropped_image.size > 0:
                resized_image = transform.resize(cropped_image, (128,
128), anti_aliasing=True)

                resized_image = img_as_ubyte(resized_image)

                new_path = image_paths[i].replace('mulinti',
'Cropped').replace('.jpg', f'-{j}.jpg')

                os.makedirs(os.path.dirname(new_path), exist_ok=True)

                io.imsave(new_path, resized_image)

def process_images(image_paths, annotation_paths):
    """Crop and resize images based on bounding box annotations."""
    print("Number of image paths:", len(image_paths))
    print("Number of annotation paths:", len(annotation_paths))
    for i in range(min(len(image_paths), len(annotation_paths))):
        print("Processing image", i)
        print("Image path:", image_paths[i])
        print("Annotation path:", annotation_paths[i])
        bounding_boxes = get_bounding_boxes(annotation_paths[i])

```

```

        original_image = io.imread(image_paths[i])
        for j, bbox in enumerate(bounding_boxes):
            cropped_image = original_image[bbox[1]:bbox[3],
bbox[0]:bbox[2]]
            if cropped_image.size > 0:
                resized_image = resize(cropped_image, (128, 128),
anti_aliasing=True)
                resized_image = img_as_ubyte(resized_image)
                new_path = image_paths[i].replace('mulinti',
'Cropped').replace('.jpg', f'-{j}.jpg')
                os.makedirs(os.path.dirname(new_path), exist_ok=True)
                io.imsave(new_path, resized_image)

```

*# Q 1: Cropping and Resize Images*

```

process_images(dog_images['n02110806-basenji'],
annotations['n02110806-basenji'])

```

Number of image paths: 441

Number of annotation paths: 209

Processing image 0

Image path:

/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1019.jpg

Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1013

Processing image 1

Image path:

/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1013.jpg

Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1577

Processing image 2

Image path:

/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_111.jpg

Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1228

Processing image 3

Image path:

/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1514.jpg

Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1382

Processing image 4

Image path:

/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1214.jpg

Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1525

Processing image 5

Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1396.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1102  
Processing image 6  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1259.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1019  
Processing image 7  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1485.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1369  
Processing image 8  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1369.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1033  
Processing image 9  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1382.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_111  
Processing image 10  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1404.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1259  
Processing image 11  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1179.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1035  
Processing image 12  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1102.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1100  
Processing image 13  
Image path:

/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1637.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1236  
Processing image 14  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1236.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1485  
Processing image 15  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1100.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1514  
Processing image 16  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1525.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1404  
Processing image 17  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1359.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1637  
Processing image 18  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1033.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1179  
Processing image 19  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1639.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1359  
Processing image 20  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1035.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1396  
Processing image 21  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1228

.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1214  
Processing image 22  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1667  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2100  
Processing image 23  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1674  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_17  
Processing image 24  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1577  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1778  
Processing image 25  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1904  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1902  
Processing image 26  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2100  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1639  
Processing image 27  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1778  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2006  
Processing image 28  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2208  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2208  
Processing image 29  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1826  
.jpg

Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1841  
Processing image 30  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1942.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1674  
Processing image 31  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2157.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1667  
Processing image 32  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2006.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_238  
Processing image 33  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1845.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2580  
Processing image 34  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_18.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2356  
Processing image 35  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_17.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_18  
Processing image 36  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1902.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2157  
Processing image 37  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1688.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-

```
basenji/n02110806_1916
Processing image 38
Image path:
/content/drive/MyDrive/mulinti_images/n02110806-basenji/n02110806_1841
.jpg
Annotation path: /content/drive/MyDrive/mulinti_annotation/n02110806-
basenji/n02110806_1845
Processing image 39
Image path:
/content/drive/MyDrive/mulinti_images/n02110806-basenji/n02110806_2349
.jpg
Annotation path: /content/drive/MyDrive/mulinti_annotation/n02110806-
basenji/n02110806_1688

<ipython-input-7-a946bd97602f>:18: UserWarning:
/content/drive/MyDrive/Cropped_images/n02110806-basenji/n02110806_2349
-0.jpg is a low contrast image
  io.imsave(new_path, resized_image)

Processing image 40
Image path:
/content/drive/MyDrive/mulinti_images/n02110806-basenji/n02110806_2580
.jpg
Annotation path: /content/drive/MyDrive/mulinti_annotation/n02110806-
basenji/n02110806_2421
Processing image 41
Image path:
/content/drive/MyDrive/mulinti_images/n02110806-basenji/n02110806_2810
.jpg
Annotation path: /content/drive/MyDrive/mulinti_annotation/n02110806-
basenji/n02110806_2365
Processing image 42
Image path:
/content/drive/MyDrive/mulinti_images/n02110806-basenji/n02110806_2421
.jpg
Annotation path: /content/drive/MyDrive/mulinti_annotation/n02110806-
basenji/n02110806_2349
Processing image 43
Image path:
/content/drive/MyDrive/mulinti_images/n02110806-basenji/n02110806_2551
.jpg
Annotation path: /content/drive/MyDrive/mulinti_annotation/n02110806-
basenji/n02110806_1942
Processing image 44
Image path:
/content/drive/MyDrive/mulinti_images/n02110806-basenji/n02110806_2497
.jpg
Annotation path: /content/drive/MyDrive/mulinti_annotation/n02110806-
basenji/n02110806_1904
Processing image 45
```



Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2774.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2249  
Processing image 46  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2356.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_1826  
Processing image 47  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2627.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2497  
Processing image 48  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_238.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2627  
Processing image 49  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2365.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2551  
Processing image 50  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2630.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3123  
Processing image 51  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2249.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3171  
Processing image 52  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2716.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3093  
Processing image 53  
Image path:

/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2926.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2774  
Processing image 54  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3415.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3331  
Processing image 55  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3093.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3673  
Processing image 56  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3513.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3711  
Processing image 57  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2997.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2860  
Processing image 58  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3376.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3056  
Processing image 59  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3056.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3006  
Processing image 60  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3006.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2995  
Processing image 61  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_346.

jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2997  
Processing image 62  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_318.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3531  
Processing image 63  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3331.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3376  
Processing image 64  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3489.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3751  
Processing image 65  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3484.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3415  
Processing image 66  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2957.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3638  
Processing image 67  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3171.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2810  
Processing image 68  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2995.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2630  
Processing image 69  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2903.jpg

Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3138  
Processing image 70  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_2860.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3513  
Processing image 71  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3135.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_346  
Processing image 72  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3008.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3135  
Processing image 73  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3123.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3484  
Processing image 74  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3138.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3136  
Processing image 75  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3883.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3702  
Processing image 76  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3751.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3581  
Processing image 77  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3711.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-

basenji/n02110806\_2716  
Processing image 78  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3581.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_318  
Processing image 79  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3929.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3489  
Processing image 80  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_376.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2926  
Processing image 81  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3008  
Processing image 82  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3781.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2903  
Processing image 83  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3903.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_2957  
Processing image 84  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3673.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_376  
Processing image 85  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3955.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3880

Processing image 86  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3531.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3883  
Processing image 87  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3638.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3995  
Processing image 88  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3880.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_402  
Processing image 89  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3937.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4012  
Processing image 90  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3956.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4055  
Processing image 91  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3966.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3827  
Processing image 92  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3968.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4058  
Processing image 93  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3970.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3956  
Processing image 94

Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3911.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3955  
Processing image 95  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3827.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3911  
Processing image 96  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3971.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3781  
Processing image 97  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3995.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3981  
Processing image 98  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3978.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4024  
Processing image 99  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4122.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3970  
Processing image 100  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4179.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4051  
Processing image 101  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4150.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3971  
Processing image 102  
Image path:

/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_402.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3966  
Processing image 103  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3974.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3978  
Processing image 104  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3981.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3968  
Processing image 105  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4012.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3903  
Processing image 106  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4142.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3974  
Processing image 107  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3929  
Processing image 108  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4156.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_3937  
Processing image 109  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4167.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4062  
Processing image 110  
Image path:  
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.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4395  
Processing image 111  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4117  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4307  
Processing image 112  
Image path:  
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.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4483  
Processing image 113  
Image path:  
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.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4322  
Processing image 114  
Image path:  
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.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4156  
Processing image 115  
Image path:  
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.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4167  
Processing image 116  
Image path:  
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.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4463  
Processing image 117  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4331  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4216  
Processing image 118  
Image path:  
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.jpg

Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4400  
Processing image 119  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_433.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4280  
Processing image 120  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4327.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_433  
Processing image 121  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4199.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4550  
Processing image 122  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4400.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4435  
Processing image 123  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4218.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4179  
Processing image 124  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4216.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4302  
Processing image 125  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4297.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4370  
Processing image 126  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4196.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4472

Processing image 127  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4297  
Processing image 128  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4280.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4122  
Processing image 129  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4289.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4488  
Processing image 130  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4291.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4150  
Processing image 131  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4435.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4242  
Processing image 132  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4302.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4105  
Processing image 133  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4244.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4196  
Processing image 134  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4188.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4117  
Processing image 135

Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4370.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4218  
Processing image 136  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4244  
Processing image 137  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4142  
Processing image 138  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4327  
Processing image 139  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4188  
Processing image 140  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4198  
Processing image 141  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4463.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4072  
Processing image 142  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4331  
Processing image 143  
Image path:

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jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_4291  
Processing image 144  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4876  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_4289  
Processing image 145  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_5114  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_4199  
Processing image 146  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4888  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_4741  
Processing image 147  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4792  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_4627  
Processing image 148  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4615  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_469  
Processing image 149  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4488  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_5688  
Processing image 150  
Image path:  
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jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_4994  
Processing image 151  
Image path:  
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jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_479  
Processing image 152  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5861  
Processing image 153  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4888  
Processing image 154  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_513.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5381  
Processing image 155  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5051  
Processing image 156  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4741.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5663  
Processing image 157  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4853  
Processing image 158  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4627.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5744  
Processing image 159  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_4966.jpg

Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4876  
Processing image 160  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_581.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_563  
Processing image 161  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_5301.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4966  
Processing image 162  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_563.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5642  
Processing image 163  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_5744.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5971  
Processing image 164  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_6080  
Processing image 165  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_5381.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_581  
Processing image 166  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5343  
Processing image 167  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_5660.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-

basenji/n02110806\_5301  
Processing image 168  
Image path:  
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.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_487  
Processing image 169  
Image path:  
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.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4711  
Processing image 170  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5114  
Processing image 171  
Image path:  
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.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5389  
Processing image 172  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_5663  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_513  
Processing image 173  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_5688  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_6066  
Processing image 174  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_5692  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_6016  
Processing image 175  
Image path:  
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.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4615



Processing image 176  
Image path:  
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Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5660  
Processing image 177  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6156.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_4792  
Processing image 178  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6528.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_6035  
Processing image 179  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6066.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5537  
Processing image 180  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_5861.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_518  
Processing image 181  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6035.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5692  
Processing image 182  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6678.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_5312  
Processing image 183  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6137.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_582  
Processing image 184

Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_582.  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_5256  
Processing image 185  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_673.  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_5238  
Processing image 186  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6424  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_6352  
Processing image 187  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6352  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_6528  
Processing image 188  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6282  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_759  
Processing image 189  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6554  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_884  
Processing image 190  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6080  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_6137  
Processing image 191  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_5971  
.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-  
basenji/n02110806\_6247  
Processing image 192  
Image path:

/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6380.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_6323  
Processing image 193  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6016.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_749  
Processing image 194  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6323.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_6282  
Processing image 195  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6542.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_839  
Processing image 196  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_6247.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_6380  
Processing image 197  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_762.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_761  
Processing image 198  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_884.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_757  
Processing image 199  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_761.jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_6554  
Processing image 200  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_979.

jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_849  
Processing image 201  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_759.  
jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_6542  
Processing image 202  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_849.  
jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_762  
Processing image 203  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_749.  
jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_6424  
Processing image 204  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_919.  
jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_6156  
Processing image 205  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_839.  
jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_6678  
Processing image 206  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_3136.  
jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_919  
Processing image 207  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_757.  
jpg  
Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_979  
Processing image 208  
Image path:  
/content/drive/MyDrive/mulinti\_images/n02110806-basenji/n02110806\_1916.  
jpg

Annotation path: /content/drive/MyDrive/mulinti\_annotation/n02110806-basenji/n02110806\_673

## Image Processing

- i. Choose 2 images from each class.
- ii. Convert the color images to grayscale images
- iii. Plot the 8 grayscale images with their corresponding pixel intensity histograms
- iv. Using the 8 grayscale images above, perform edge detection
- v. Plot the 8 edge images

```
import os
from skimage import io, color, exposure, filters
import matplotlib.pyplot as plt

def image_processing(dog_images):
    """Image Processing."""
    selected_images = []
    for cls in dog_images.keys():
        selected_images.extend(dog_images[cls][:2])
        if len(selected_images) >= 8:
            break
    selected_images = selected_images[:8]

    plt.figure(figsize=(20, 10))
    for idx, img_path in enumerate(selected_images, 1):
        img = io.imread(img_path)
        gray_img = color.rgb2gray(img)

        plt.subplot(2, 8, idx)
        plt.imshow(gray_img, cmap='gray')
        plt.title('Gray Image')

        plt.subplot(2, 8, idx + 8)
        hist, bins = exposure.histogram(gray_img, nbins=256)
        plt.plot(bins, hist)
        plt.xlabel('Pixel Intensity')
        plt.ylabel('Frequency')
        plt.title('Histogram')

    plt.tight_layout()
    plt.show()

    plt.figure(figsize=(20, 10))
    for idx, img_path in enumerate(selected_images, 1):
        img = io.imread(img_path)
```

```

gray_img = color.rgb2gray(img)

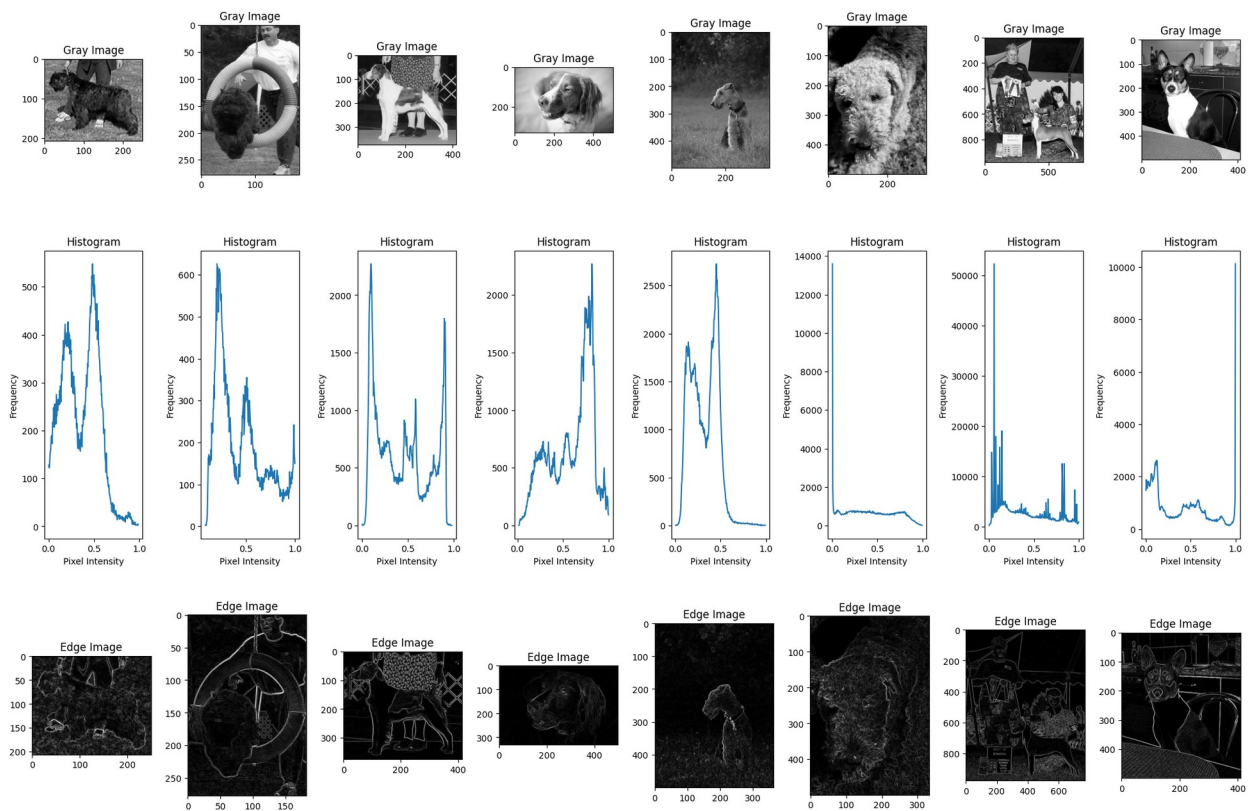
edges = filters.sobel(gray_img)

plt.subplot(2, 8, idx)
plt.imshow(edges, cmap='gray')
plt.title('Edge Image')

plt.tight_layout()
plt.show()

```

# Q 2b: Image Processing  
image\_processing(dog\_images)

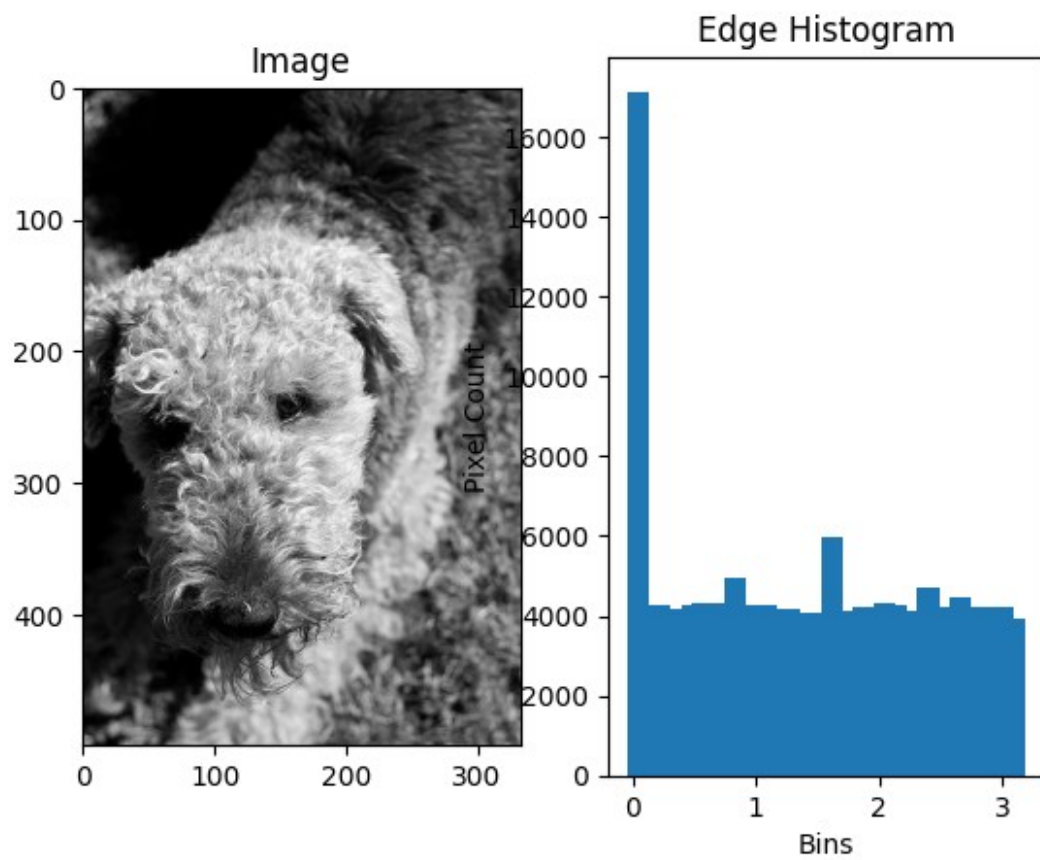


## Edge histogram

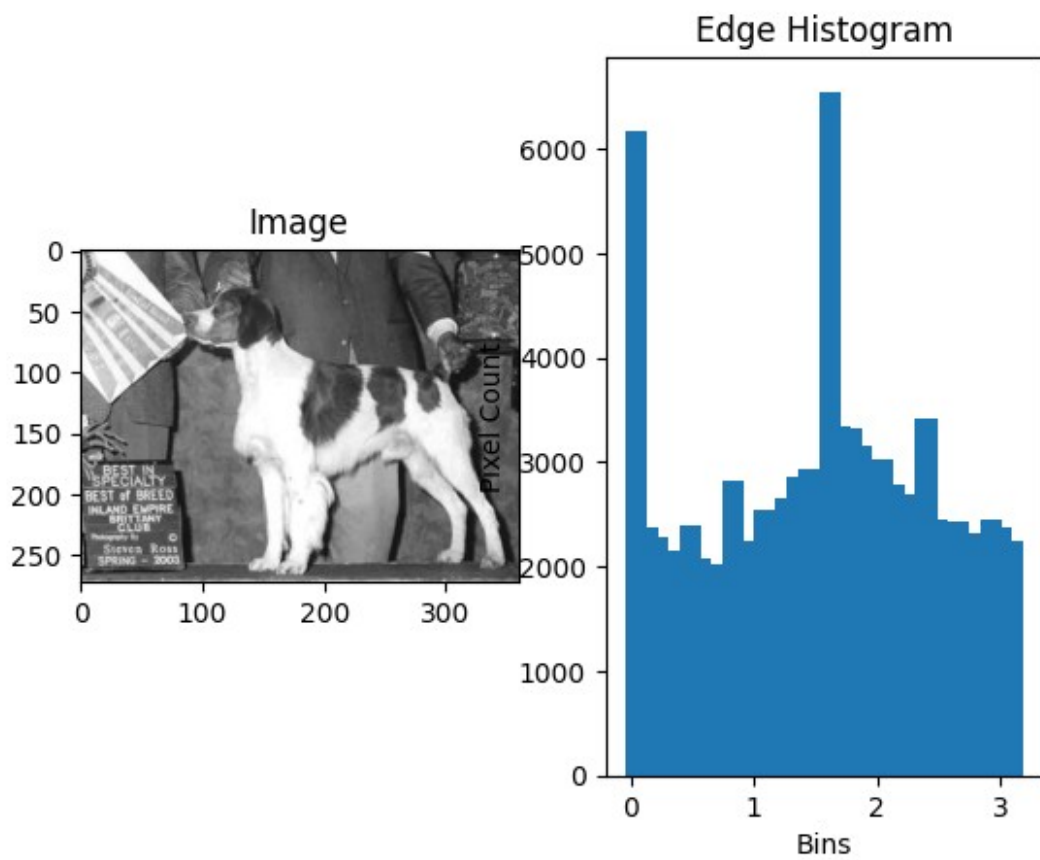
- i. Choose 1 image from each class.
- ii. Convert the color images to grayscale images
- iii. For each image  $I$ , use the following import numpy as np from skimage import filters def angle(dx, dy): """Calculate the angles between horizontal and vertical operators.""" return np.mod(np.arctan2(dy, dx), np.pi) angle\_sobel = angle(filters.sobel\_h(I), filters.sobel\_v(I)) to obtain an “angle” for each pixel in the images (Intuitively, one can think of the “angle” as the direction of edge gradient at the pixel).

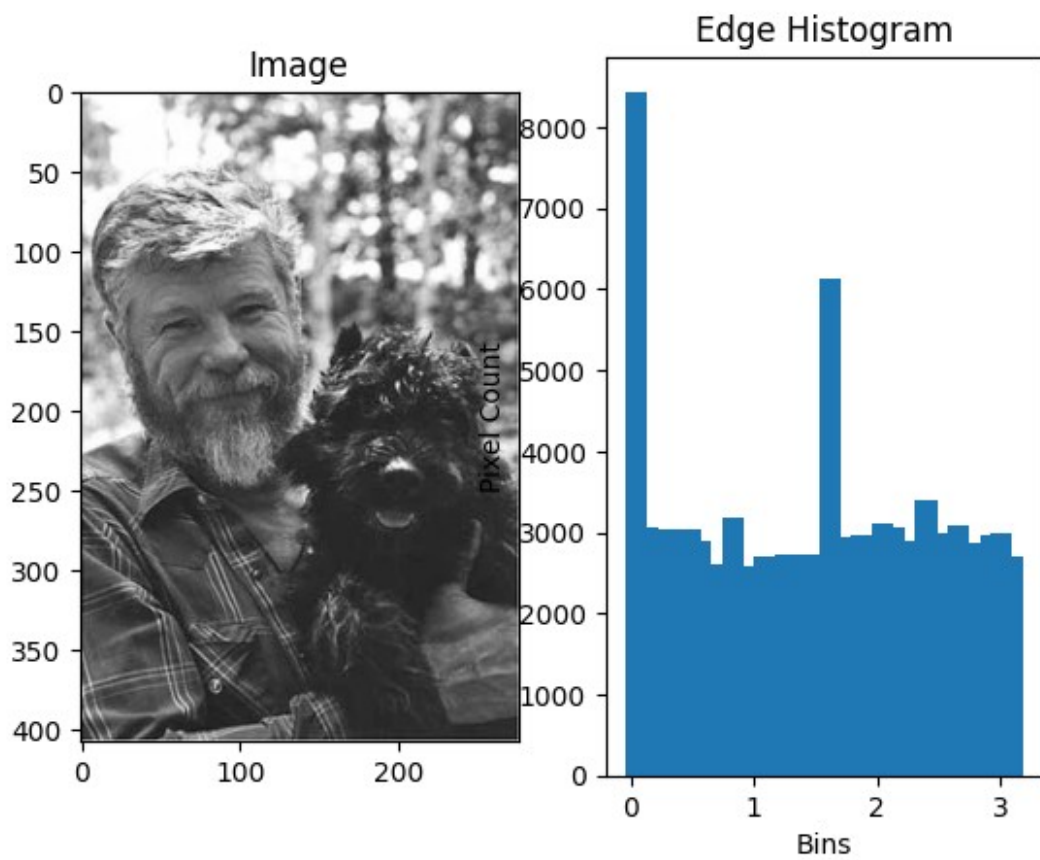
- iv. Use `skimage.exposure.histogram` to obtain a histogram with 36 bins. (1 point)
- v. Plot the images with their corresponding edge histogram values (add x-axis label "Bins" and y-axis label "Pixel Count"). (1 point)

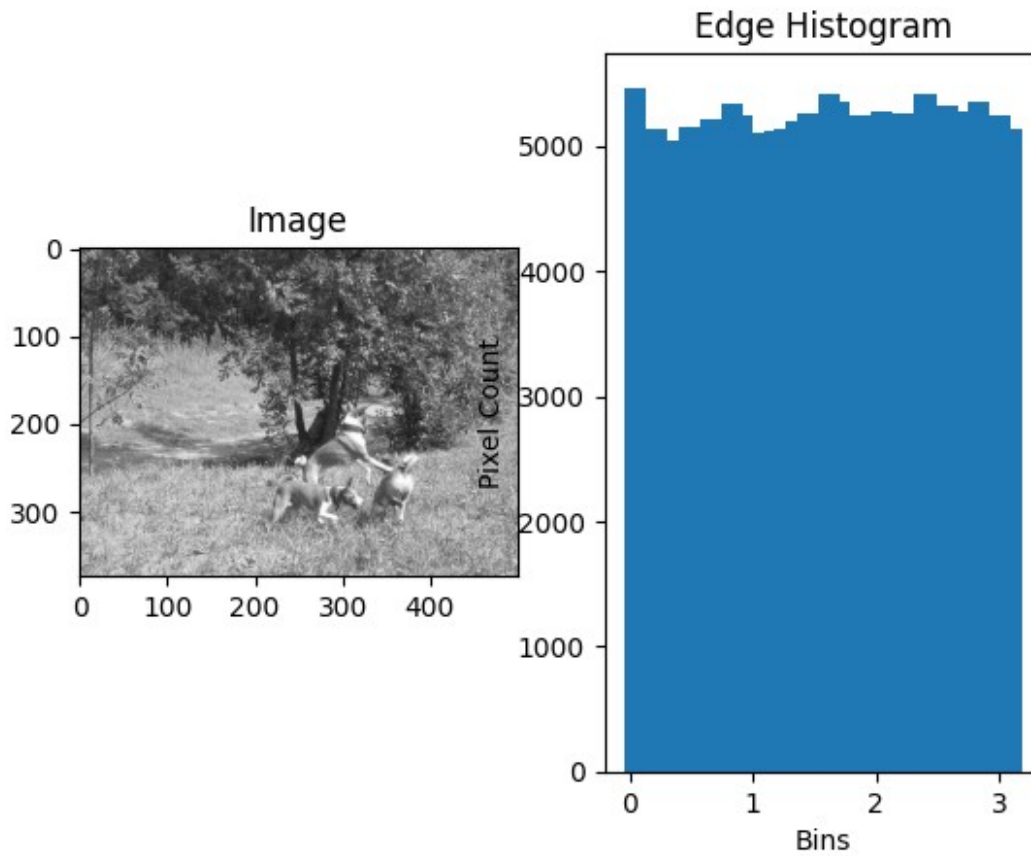
```
def edge_histogram(image_path):  
    """Edge histogram."""  
    img = io.imread(image_path)  
    gray_img = color.rgb2gray(img)  
    dx, dy = np.gradient(gray_img)  
    angle_sobel = np.mod(np.arctan2(dy, dx), np.pi)  
    hist, bins = exposure.histogram(angle_sobel, nbins=36)  
    plt.subplot(1, 2, 1)  
    plt.imshow(gray_img, cmap='gray')  
    plt.title('Image')  
    plt.subplot(1, 2, 2)  
    plt.bar(bins, hist, width=np.pi / 18)  
    plt.xlabel('Bins')  
    plt.ylabel('Pixel Count')  
    plt.title('Edge Histogram')  
    plt.show()  
  
# Q 2c: Edge histogram  
edge_histogram('/content/drive/MyDrive/mulinti_images/n02096051-  
Airedale/n02096051_1017.jpg')  
edge_histogram('/content/drive/MyDrive/mulinti_images/n02101388-  
Brittany_spaniel/n02101388_2689.jpg')  
edge_histogram('/content/drive/MyDrive/mulinti_images/n02106382-  
Bouvier_des_Flandres/n02106382_1731.jpg')  
edge_histogram('/content/drive/MyDrive/mulinti_images/n02110806-  
basenji/n02110806_849.jpg')
```











## Histogram Comparison (Measures of Similarity and Dissimilarity)

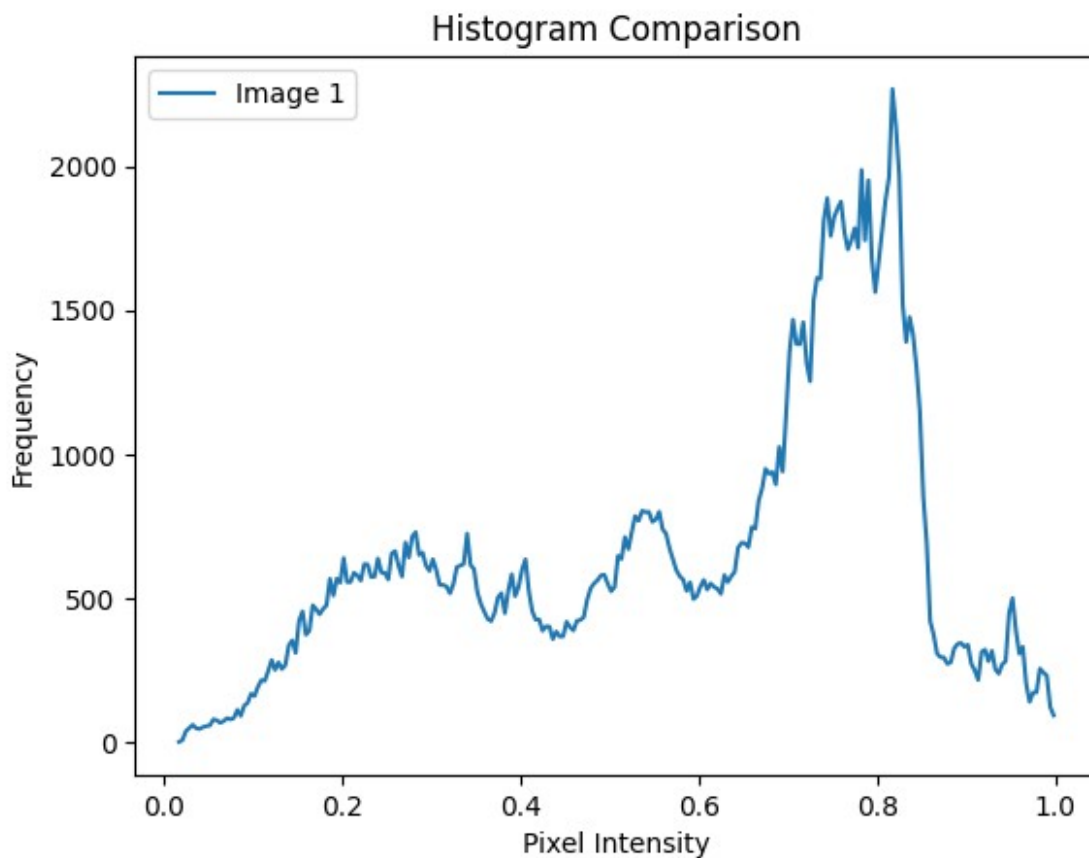
- Pick 2 images from the same class and 1 image from another class.
- Convert the three images to edge histograms. (These will be the vector representations of the images)
- Perform histogram comparison using the following metrics/measures.
  - Euclidean distance
  - Manhattan distance
  - Cosine distance
 Using the 3 images above, you will compare histograms by computing the metrics/measures of (1) the 2 images from the same class, AND (2) 2 images from different classes. (1.5 points)

```
def histogram_comparison(img_path1, img_path2, img_path3):
    """Histogram Comparison."""
    images = [io.imread(img_path1), io.imread(img_path2),
io.imread(img_path3)]
    for i, img in enumerate(images):
        gray_img = color.rgb2gray(img)
        hist, bins = exposure.histogram(gray_img, nbins=256)
        plt.plot(bins, hist, label=f'Image {i + 1}')
        plt.xlabel('Pixel Intensity')
```

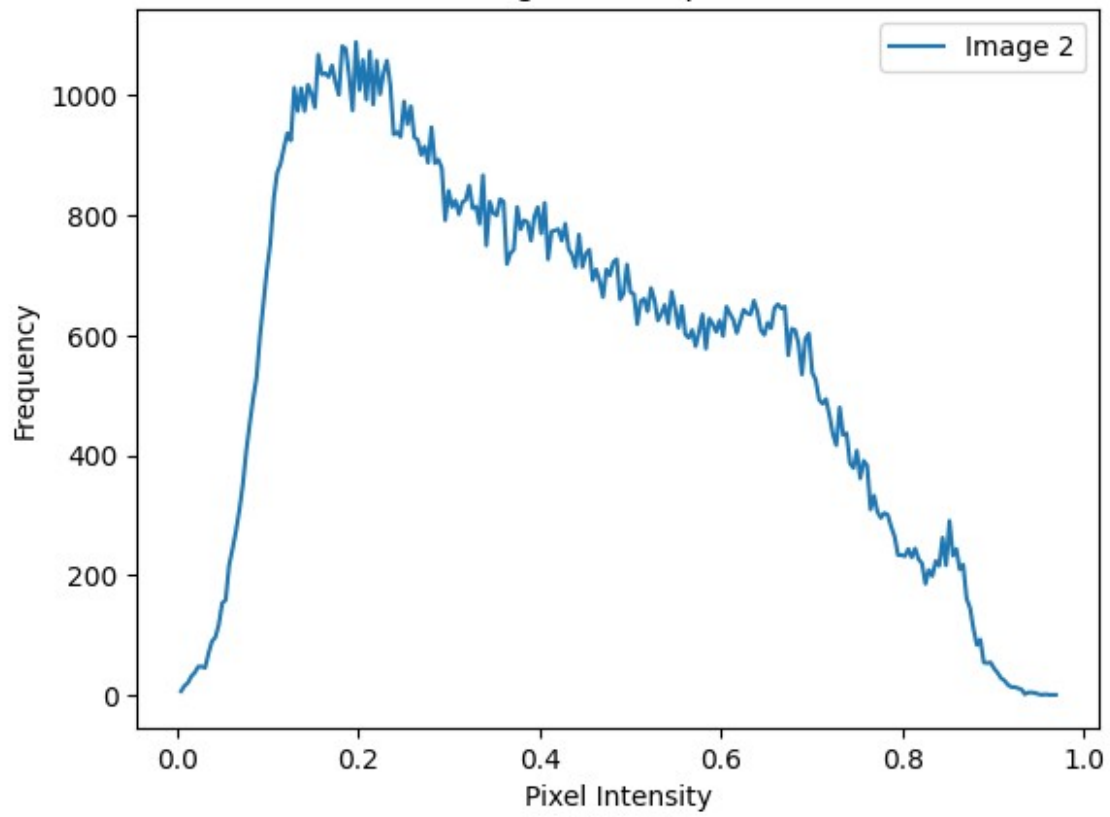
```
plt.ylabel('Frequency')
plt.title('Histogram Comparison')
plt.legend()
plt.show()
```

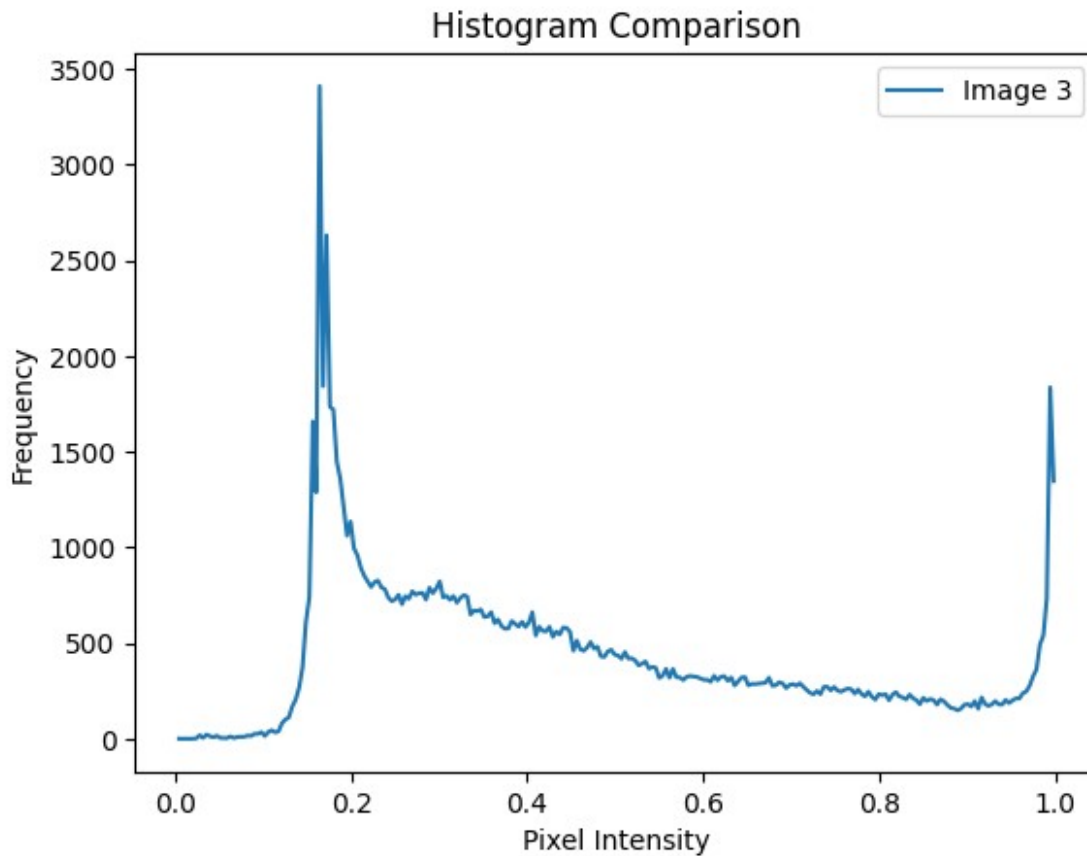
*# Q 2d: Histogram Comparison*

```
histogram_comparison('/content/drive/MyDrive/mulinti_images/n02101388-  
Brittany_spaniel/n02101388_10017.jpg',  
'/content/drive/MyDrive/mulinti_images/n02101388-Brittany_spaniel/  
n02101388_10107.jpg',  
'/content/drive/MyDrive/mulinti_images/n02106382-  
Bouvier_des_Flandres/n02106382_1731.jpg')
```



Histogram Comparison





## Histogram of Oriented Gradient (HOG) feature descriptor

i. Pick 1 image and compute its HOG descriptors. Visualise the image and the HOG descriptors for the image

```
def hog_descriptor(image_path):
    """Histogram of Oriented Gradient (HOG) feature descriptor."""
    img = io.imread(image_path)
    gray_img = color.rgb2gray(img)
    orientations = 9
    pixels_per_cell = (8, 8)
    cells_per_block = (2, 2)
    hog_features, hog_image = hog(gray_img, orientations=orientations,
                                   pixels_per_cell=pixels_per_cell,
                                   cells_per_block=cells_per_block,
                                   block_norm='L2-Hys',
                                   visualize=True, multichannel=False)

    fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(12, 6), sharex=True,
    sharey=True)
    ax1.imshow(gray_img, cmap=plt.cm.gray)
    ax1.set_title('Input Image')
```

```

    hog_image_rescaled = exposure.rescale_intensity(hog_image,
in_range=(0, 10))
    ax2.imshow(hog_image_rescaled, cmap=plt.cm.gray)
    ax2.set_title('Histogram of Oriented Gradients')
    plt.show()

```

```

# Q 2e: Histogram of Oriented Gradient (HOG) feature descriptor
hog_descriptor('/content/drive/MyDrive/mulinti_images/n02110806-
basenji/n02110806_1013.jpg')
hog_descriptor('/content/drive/MyDrive/mulinti_images/n02106382-
Bouvier_des_Flandres/n02106382_1000.jpg')

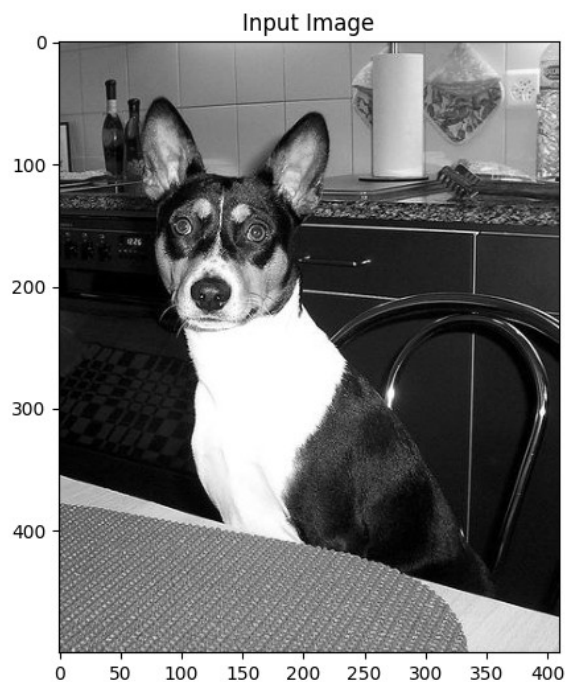
```

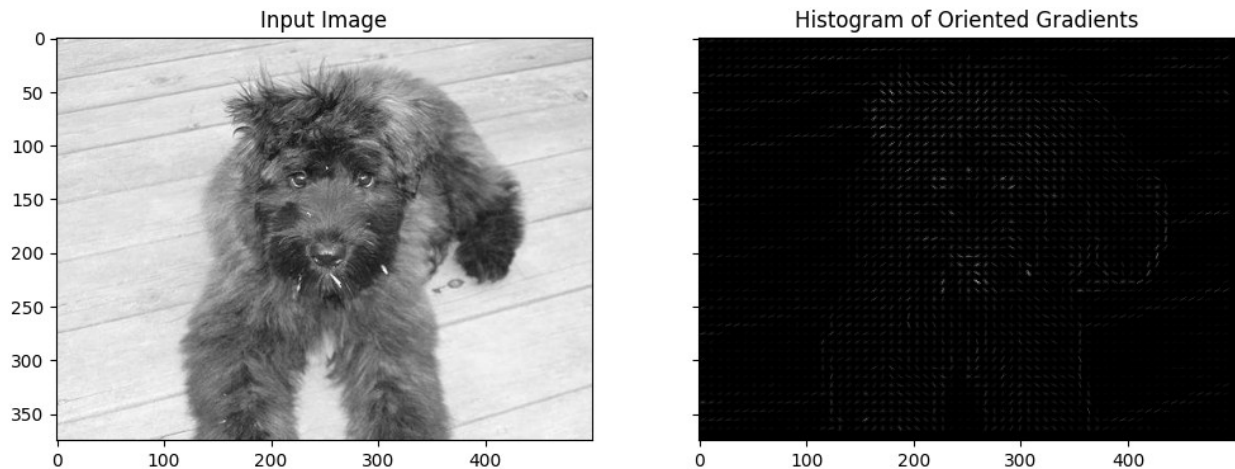
<ipython-input-14-783f5f18223a>:8: FutureWarning: `multichannel` is a deprecated argument name for `hog`. It will be removed in version 1.0. Please use `channel\_axis` instead.

```

    hog_features, hog_image = hog(gray_img, orientations=orientations,

```





## Dimensionality reduction (using Principal Component Analysis, PCA)

- i. Use images from any two classes.
- ii. Convert all the images from the two classes to edge histograms.(0.5 points)
- iii. Perform Principal Component Analysis (PCA) dimensionality reduction on the set of histograms to reduce from 36 to 2 dimensions. (Note: You should not use the class labels) (1 point)
- iv. Plot the 2D points using 2 different colors for data from the 2 classes (see Figure 1). Are your data from the two classes separable? (1 point)

```
import numpy as np
import os
from skimage import io, color, exposure, filters
from sklearn.decomposition import PCA
import matplotlib.pyplot as plt

def pca_dimensionality_reduction(edge_hist_vectors):
    """Dimensionality reduction (using Principal Component Analysis,
    PCA)."""
    if not edge_hist_vectors:
        print("Error: Input array is empty.")
        return
    X = np.vstack(edge_hist_vectors)
    pca = PCA(n_components=2)
    reduced_data = pca.fit_transform(X)
    plt.figure(figsize=(8, 6))

    plt.scatter(reduced_data[:15, 0], reduced_data[:15, 1],
        label='Class 1: Airedale')
    plt.scatter(reduced_data[15:, 0], reduced_data[15:, 1],
```



```

label='Class 2: basenji')

plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.title('PCA Dimensionality Reduction')
plt.legend()
plt.show()

# Q 2f: Dimensionality reduction (using Principal Component Analysis,
PCA)
edge_hist_vectors = []

for img_path in dog_images['n02096051-Airedale'][:15] +
dog_images['n02110806-basenji'][:15]:
    img = io.imread(img_path)
    gray_img = color.rgb2gray(img)
    edges = filters.sobel(gray_img) # Edge detection
    hist, _ = exposure.histogram(edges, nbins=36) # Histogram
    calculation
    edge_hist_vectors.append(hist)

pca_dimensionality_reduction(edge_hist_vectors)

```

