VALIDACION DEL MODELO

- Basicament utilizando el algoritmo de neirest neighbors (k neirest neighbors con k = 1), en donde los puntos dados son los centroides calculados durante el entrenamiento, se busca clasificar una nueva fruta en el cluster de uno de loos centroides.

LIBRERIAS

In [ ]:
```
import os
import numpy as np
import cv2
import matplotlib.pylab as plt
from sklearn.cluster import KMeans
import joblib
from scipy.spatial.distance import cdist
```

PATHS

In [ ]:
```
image_path          = '../../../dataset/images'
validation_path     = os.path.join(image_path, 'validation')
original_path       = os.path.join(validation_path, 'original')
processed_path      = os.path.join(validation_path, 'processed')
training_data       = 'training_data.pkl'
```

LISTAS DE IMAGENES

In [ ]:
```
original    = [os.path.join(original_path, image) for image in os.listdir(o
```

PROCESAMIENTO DE LAS IMÁGENES

In [ ]:
```
def get_light_background(mask, f = 20, p = 0.75):
    height, width = mask.shape
    cluster_size  = min([height, width])//f
    cluster       = np.ones((cluster_size, cluster_size), np.uint8)

    # Corners
    corner1 = np.bitwise_and(cluster, mask[:cluster_size,  :cluster_size])
    corner2 = np.bitwise_and(cluster, mask[:cluster_size:, -cluster_size:]
    corner3 = np.bitwise_and(cluster, mask[-cluster_size:, :cluster_size])
    corner4 = np.bitwise_and(cluster, mask[-cluster_size:, -cluster_size:]
    corners = [corner1, corner2, corner3, corner4]

    # Sides
    limitw1 = (width - cluster_size)//2
    limitw2 = (width + cluster_size)//2
    limith1 = (height - cluster_size)//2
    limith2 = (height + cluster_size)//2
```

```python
    side1   = np.bitwise_and(cluster, mask[:cluster_size, limitw1:limitw2]
    side2   = np.bitwise_and(cluster, mask[limith1:limith2, :cluster_size]
    side3   = np.bitwise_and(cluster, mask[limith1:limith2, -cluster_size:
    side4   = np.bitwise_and(cluster, mask[-cluster_size:, limitw1:limitw2
    sides   = [side1, side2, side3, side4]

    # Determining the type of background
    edges            = corners + sides
    light_background = sum(np.count_nonzero(edge) for edge in edges) > p*8

    # Inverting if dark background
    if light_background:
        return np.bitwise_not(mask)
    return mask
```

In [ ]:

```python
for file in original:
    # BGR image
    image = cv2.imread(file)

    # Dimenssions
    height, width, _ = image.shape

    # Pixel data vector
    data_vector = np.zeros((height * width, 4))

    # Obtener matrices del espacio de colores
    rgb_matrix = image.reshape((-1, 3))
    hsv_matrix = cv2.cvtColor(image, cv2.COLOR_BGR2HSV).reshape((-1, 3))
    lab_matrix = cv2.cvtColor(image, cv2.COLOR_BGR2LAB).reshape((-1, 3))

    # Asignar a la matriz de datos
    # Conservamos el canal G, S, A y B
    data_vector[:, 0]  = rgb_matrix[:, 2]
    data_vector[:, 1]  = hsv_matrix[:, 1]
    data_vector[:, 2:] = lab_matrix[:, 1:]

    # Segmentamos la imagen con los vectores obtenidos pos cada pixel
    kmeans = KMeans(n_clusters = 2, n_init = 10, random_state=42)  # 2 Clu
    kmeans.fit(data_vector)

    # Get clusters labels
    labels = kmeans.labels_

    # kmeans_mask
    kmeans_mask = labels.reshape(height, width)
    kmeans_mask = kmeans_mask.astype(np.uint8) * 255

    # Determinación del tipo de fondo de la máscara
    kmeans_mask = get_light_background(kmeans_mask)

    # Erosion y dilataciòn sobre la màscara
    erosion_size      = min([height, width])//200
    dilatacion_size   = min([height, width])//80
    kernel_erosion    = np.ones((erosion_size,erosion_size), np.uint8)
```

```
    eroded               = cv2.erode(kmeans_mask, kernel_erosion, iterations
    kernel_dilatacion = np.ones((dilatacion_size,dilatacion_size), np.uint
    kmeans_mask          = cv2.dilate(eroded, kernel_dilatacion, iterations

    # Encontrar contornos
    kmeans_cnt, _ = cv2.findContours(kmeans_mask, cv2.RETR_EXTERNAL, cv2.C
    kmeans_cnt    = max(kmeans_cnt, key = cv2.contourArea)

    # Contorno aproximado
    epsilon       = 0.001 * cv2.arcLength(kmeans_cnt, True)
    kmeans_cnt    = cv2.approxPolyDP(kmeans_cnt, epsilon, True)
    kmeans_cnt    = (kmeans_cnt,)

    # Template
    tkmeans       = np.zeros((height, width), dtype=np.uint8)

    # Dibujar
    cv2.drawContours(tkmeans, kmeans_cnt, -1, 255, thickness = cv2.FILLED)

    # Guardar mascara
    cv2.imwrite(os.path.join(processed_path, os.path.basename(file)), tkme
```

In [ ]:
```
processed  = [os.path.join(processed_path, image) for image in os.listdir(
```

RANGOS DE COLOR

In [ ]:
```
lower_red_2 = np.array([170, 60, 60])
upper_red_2 = np.array([179, 255, 255])

lower_red_1 = np.array([0, 60, 60])
upper_red_1 = np.array([8, 255, 255])

lower_orange = np.array([8, 120, 80])
upper_orange = np.array([21, 255, 255])

lower_yellow = np.array([21, 50, 80])
upper_yellow = np.array([25, 255, 255])

lower_green = np.array([25, 40, 40])
upper_green = np.array([100, 255, 255])
```

EXTRACCIÓN DE CARACTERÍSTICAS

In [ ]:
```
conversion_color = {'V' :-20, 'R' : -10, 'A' : 10, 'N' : 20}
names            = [os.path.basename(file) for file in original]
image_features   = dict.fromkeys(names)

for image_file, mask_file in zip(original, processed):
    # Leer la imagen y la máscara
    image = cv2.imread(image_file)
    mask  = cv2.imread(mask_file, cv2.IMREAD_GRAYSCALE)

    # Convertir la imagen de BGR a HSV
```

```
hsv_image = cv2.cvtColor(image, cv2.COLOR_BGR2HSV)

# Aplicar la máscara
fruit = cv2.bitwise_and(hsv_image, hsv_image, mask=mask)

#---------------Extracción de los momentos de Hu----------------------

# Encontrar el rectángulo delimitador de la fruta
(x, y, w, h) = cv2.boundingRect(mask)

# Recortar la imagen original para obtener solo la región de la fruta
trimed  = fruit[y:y + h, x:x + w]

# Convertir la imagen a escala de grises si es necesario
trimed_gray = cv2.cvtColor(trimed, cv2.COLOR_BGR2GRAY)

# Calcular los momentos de la imagen
momentos = cv2.moments(trimed_gray)

# Calcular los momentos de Hu
momentos_hu = cv2.HuMoments(momentos)

# Aplicar logaritmo a los momentos de Hu para mejorar la escala
log_moments_hu = -np.sign(momentos_hu) * np.log10(np.abs(momentos_hu))
moments = log_moments_hu.reshape(-1)

#----------------------Extracción de color------------------------
conteo = {
    'V' : np.sum(np.all(np.logical_and(lower_green  <= fruit, fruit <=
    'R1': np.sum(np.all(np.logical_and(lower_red_1  <= fruit, fruit <=
    'R2': np.sum(np.all(np.logical_and(lower_red_2  <= fruit, fruit <=
    'A' : np.sum(np.all(np.logical_and(lower_yellow <= fruit, fruit <=
    'N' : np.sum(np.all(np.logical_and(lower_orange <= fruit, fruit <=
}
conteo_por_rango = {
    'V': conteo['V'],
    'R': conteo['R1'] + conteo['R2'],
    'A': conteo['A'],
    'N': conteo['N']
}

sorted_conteo = sorted(conteo_por_rango.items(), key=lambda x: x[1], r

# Obtener el segundo elemento más grande
segundo_mas_grande = sorted_conteo[1]

# Obtener la etiqueta y el valor del segundo elemento más grande
etiqueta_segundo_mas_grande = segundo_mas_grande[0]
valor_segundo_mas_grande    = segundo_mas_grande[1]

# Obtener la etiqueta basándose en el rango con el mayor conteo
etiqueta = max(conteo_por_rango, key = conteo_por_rango.get)

# Se usa el hecho de que a excepción de las manzanas, el resto de las
```

```
    if (etiqueta_segundo_mas_grande == 'R')and(valor_segundo_mas_grande >
        etiqueta = 'R'

    color = conversion_color[etiqueta]

    #-----------------Vector de características----------------------
    image_features[os.path.basename(image_file)] = np.append(moments[2:4],
```

RECUPERAMOS LOS CENTROIDES Y APLICACIÓN DE KNN

In [ ]:
```
def knn(training, test, k_n):
    X           = np.concatenate([v for v in training.values()], axis = 0)
    y           = np.concatenate([[k] * v.shape[0] for k, v in training.it
    dist        = cdist(test, X)
    sorted_ind  = np.argsort(dist, axis = 1)
    sorted_k    = sorted_ind[:, 0:k_n]
    predicted   = []

    for row in sorted_k:
        labels     = list(y[row])
        prediction = max(set(labels), key = labels.count)
        predicted.append(prediction)
    return predicted
```

In [ ]:
```
data              = joblib.load(training_data)
centroids         = data['centroids']
training_features = data['features']
training_labels   = data['labels']
prediction        = knn(centroids, np.vstack(list(image_features.values()))
```

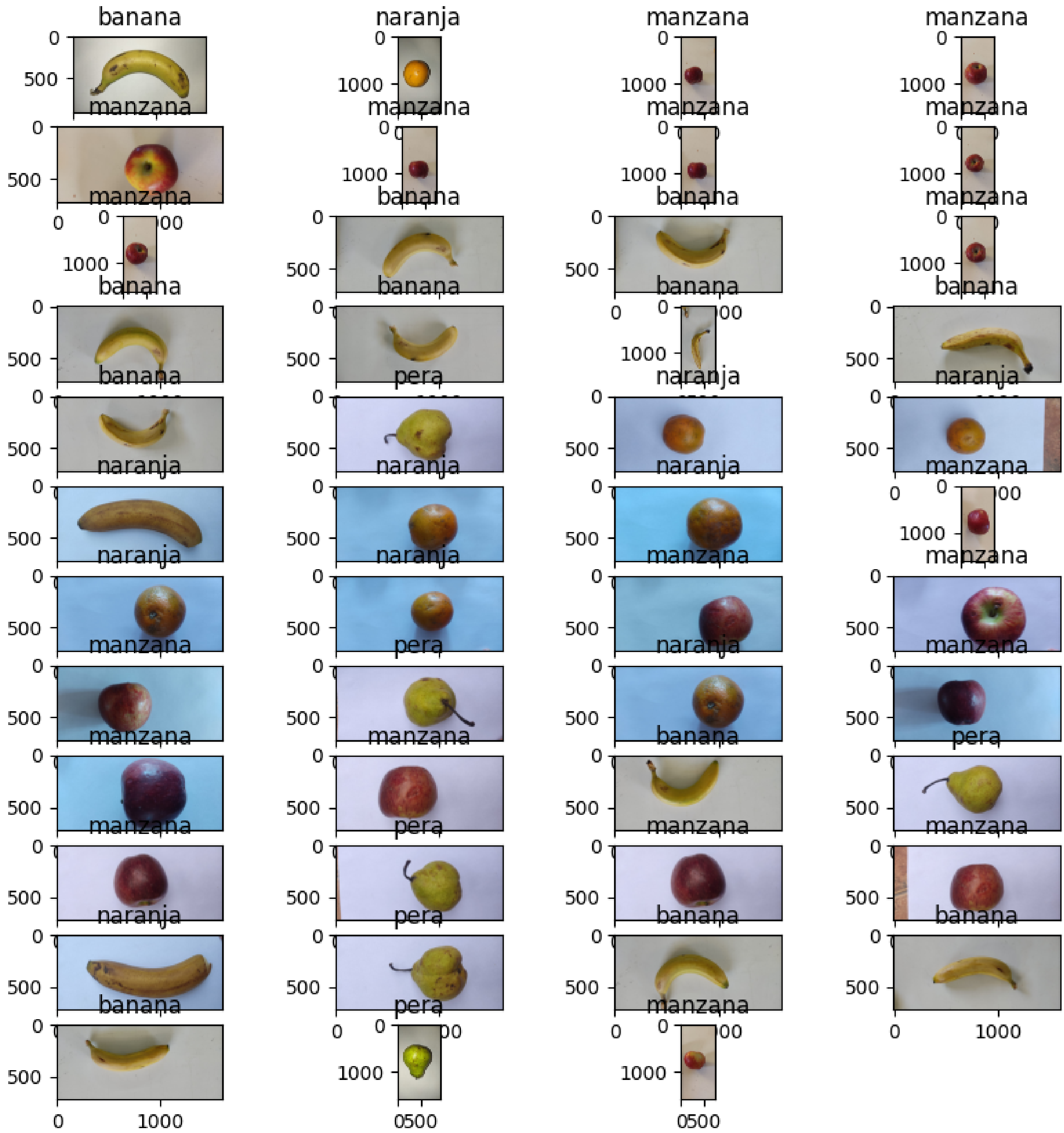
REPRESENTACIÓN DE LAS IMÁGENES CON SUS ETIQUETAS

In [ ]:
```
prediction = dict(zip(image_features.keys(), prediction))
total      = len(prediction.keys())
cols       = 4
rows       = total//cols
if total%cols != 0:
    rows += 1

i = 0
plt.figure(figsize = (10, 10))
for basename, label in prediction.items():

    file = os.path.join(original_path, basename)

    plt.subplot(rows, cols, i + 1)
    plt.imshow(cv2.cvtColor(cv2.imread(file), cv2.COLOR_BGR2RGB))
    plt.title(label)
    i += 1
plt.show()
```



REPRESENTACIÓN DE LOS PUNTOS EN EL ESPACIO

Armamos los clusters del entrenamiento

In [ ]:
```
points_matrix   = np.vstack(list(training_features.values()))
training_points = dict.fromkeys(set(training_labels.values()))

for point, label in zip(points_matrix, training_labels.values()):
    if training_points[label] is None:
        training_points[label] = []
    training_points[label].append(point)

points = dict()
for fruit, cluster in training_points.items():
    points[fruit] = np.vstack(cluster)
```

Incorporamos los puntos de las frutas de validación al diccionario

In [ ]:

```
points['validation'] = np.vstack(list(image_features.values()))
```

In [ ]:

```
#3d
fig = plt.figure()
ax = fig.add_subplot(111, projection ='3d')

color_values = []
for key in points:
    if key == 'naranja':
        color_values.append('orange')
    elif key == 'banana':
        color_values.append('yellow')
    elif key == 'pera':
        color_values.append('green')
    elif key == 'manzana':
        color_values.append('red')
    else:
        color_values.append('cyan')

colors = dict(zip(points.keys(), color_values))

for key, cluster in points.items():
    ax.scatter(cluster[:, 0], cluster[:, 1], cluster[:, 2], c=colors[key],

ax.set_xlabel('Eje X')
ax.set_ylabel('Eje Y')
ax.set_zlabel('Eje Z')
plt.show()
```