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MSSV: 21110256

Lớp: 21TTH1

In [ ]:
```
import os

path = os.getcwd()
os.chdir(path)
print(os.listdir())
```

```
['21110256_HuynhNguyenTheDan_ IS Lab01.ipynb', 'Lab01_IS_Thresholding_based_Segmentation_NEW.html', 'Object Segmentation Data']
```

In [ ]:
```
os.chdir(os.path.join(path, 'Object Segmentation Data'))
print(os.listdir())
```

```
['Activities.jpeg', 'Barcode.png', 'Bone.jpg', 'Brain.jpg', 'Car.jpg', 'Chest.jpg', 'Cloths.jpg', 'Code.jpg', 'Crack.jpg', 'Cross.jpg', 'Defect.jpg', 'Dust.jpg', 'Emotion.jpg', 'Face.jpg', 'Fire.jpg', 'Gesture.jpg', 'Hand.jpg', 'Iris.jpg', 'Leaf.jpg', 'Lung.png', 'Mask.jpg', 'Melanoma.jpg', 'QR.jpg', 'Retina.jpg', 'Shelf.jpg', 'Sign.jpg', 'Tumor.png', 'Writing.png']
```

In [ ]:
```
import numpy as np
import cv2
from matplotlib import pyplot as plt
from skimage.color import rgb2gray
from skimage.filters import threshold_otsu
from skimage.measure import label, regionprops
from skimage.segmentation import mark_boundaries
from scipy import ndimage as ndi
import pandas as pd
import json
import os
import timeit
import random
```

In [ ]:
```
def ShowImage(ImageList, nRows = 1, nCols = 2, WidthSpace = 0.00, HeightSpace =
    from matplotlib import pyplot as plt
    import matplotlib.gridspec as gridspec

    gs = gridspec.GridSpec(nRows, nCols)
    gs.update(wspace=WidthSpace, hspace=HeightSpace) # set the spacing between a
    plt.figure(figsize=(20,20))
    for i in range(len(ImageList)):
        ax1 = plt.subplot(gs[i])
        ax1.set_xticklabels([])
        ax1.set_yticklabels([])
        ax1.set_aspect('equal')

        plt.subplot(nRows, nCols,i+1)

        image = ImageList[i].copy()
        if (len(image.shape) < 3):
            plt.imshow(image, plt.cm.gray)
        else:
            plt.imshow(image)
```

```
        plt.title("Image " + str(i))
        plt.axis('off')

    plt.show()
```

In [ ]:
```
import os
import pandas as pd

def get_subfiles(dir):
    "Get a list of immediate subfiles"
    return next(os.walk(dir))[2]
```

In [ ]:
```
def ResizeImage(IM, DesiredWidth, DesiredHeight):
    from skimage.transform import rescale, resize

    OrigWidth = float(IM.shape[1])
    OrigHeight = float(IM.shape[0])
    Width = DesiredWidth
    Height = DesiredHeight

    if((Width == 0) & (Height == 0)):
        return IM

    if(Width == 0):
        Width = int((OrigWidth * Height)/OrigHeight)

    if(Height == 0):
        Height = int((OrigHeight * Width)/OrigWidth)

    dim = (Width, Height)
    resizedIM = cv2.resize(IM, dim, interpolation = cv2.INTER_NEAREST)
    return resizedIM
```

In [ ]:
```
path_Data = os.path.join(path, 'Object Segmentation Data')
os.listdir(path_Data)
```

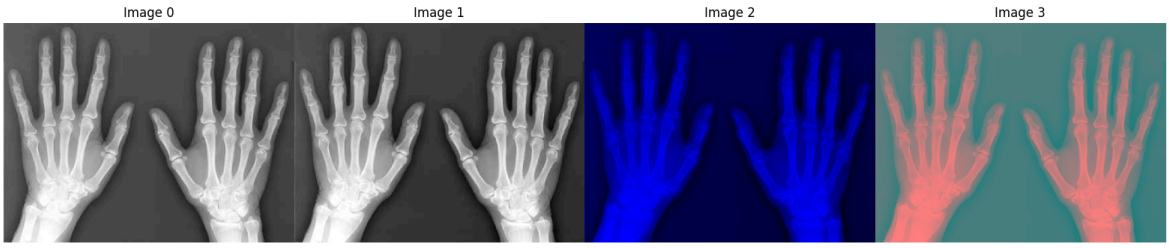
Out[ ]:
```
['Activities.jpeg',
 'Barcode.png',
 'Bone.jpg',
 'Brain.jpg',
 'Car.jpg',
 'Chest.jpg',
 'Cloths.jpg',
 'Code.jpg',
 'Crack.jpg',
 'Cross.jpg',
 'Defect.jpg',
 'Dust.jpg',
 'Emotion.jpg',
 'Face.jpg',
 'Fire.jpg',
 'Gesture.jpg',
 'Hand.jpg',
 'Iris.jpg',
 'Leaf.jpg',
 'Lung.png',
 'Mask.jpg',
 'Melanoma.jpg',
 'QR.jpg',
 'Retina.jpg',
 'Shelf.jpg',
 'Sign.jpg',
 'Tumor.png',
 'Writing.png']
```

In [ ]:
```
path_Data = os.path.join(path, 'Object Segmentation Data')
all_names = sorted(get_subfiles(path_Data))
print("Number of Images:", len(all_names))
IMG = []
for i in range(len(all_names)):
  tmp = cv2.imread(os.path.join(path_Data,all_names[i]))
  IMG.append(tmp)

ImageDB = IMG.copy()
NameDB = all_names
print(NameDB)
```

```
Number of Images: 28
['Activities.jpeg', 'Barcode.png', 'Bone.jpg', 'Brain.jpg', 'Car.jpg', 'Chest.jp
g', 'Cloths.jpg', 'Code.jpg', 'Crack.jpg', 'Cross.jpg', 'Defect.jpg', 'Dust.jpg',
'Emotion.jpg', 'Face.jpg', 'Fire.jpg', 'Gesture.jpg', 'Hand.jpg', 'Iris.jpg', 'Le
af.jpg', 'Lung.png', 'Mask.jpg', 'Melanoma.jpg', 'QR.jpg', 'Retina.jpg', 'Shelf.j
pg', 'Sign.jpg', 'Tumor.png', 'Writing.png']
```

In [ ]:
```
FileName = 'Hand.jpg'
idx = NameDB.index(FileName)
print("Selected Image : ", "\nIndex ", idx, "\nName ", NameDB[idx])

image_orig = ImageDB[idx]
image_gray = cv2.cvtColor(image_orig,cv2.COLOR_BGR2GRAY)
image_hsv = cv2.cvtColor(image_orig, cv2.COLOR_BGR2HSV)
image_ycbcr = cv2.cvtColor(image_orig, cv2.COLOR_BGR2YCR_CB)
ShowImage([image_orig, image_gray, image_hsv, image_ycbcr], 1, 4)
```

```
Selected Image :
Index  16
Name  Hand.jpg
```



In [ ]:
```python
def p_tile_threshold(image, pct):
  n_pixels = pct * image.shape[0] * image.shape[1]
  hist = np.histogram(image, bins=range(256))[0]
  hist = np.cumsum(hist)

  return np.argmin(np.abs(hist - n_pixels))
```

In [ ]:
```python
T = p_tile_threshold(image_gray, pct = 0.55)
print(T)

mask_obj = image_gray > T
mask_bg = image_gray <= T
ShowImage([image_gray, mask_obj, mask_bg], 1, 3)
```

```
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```

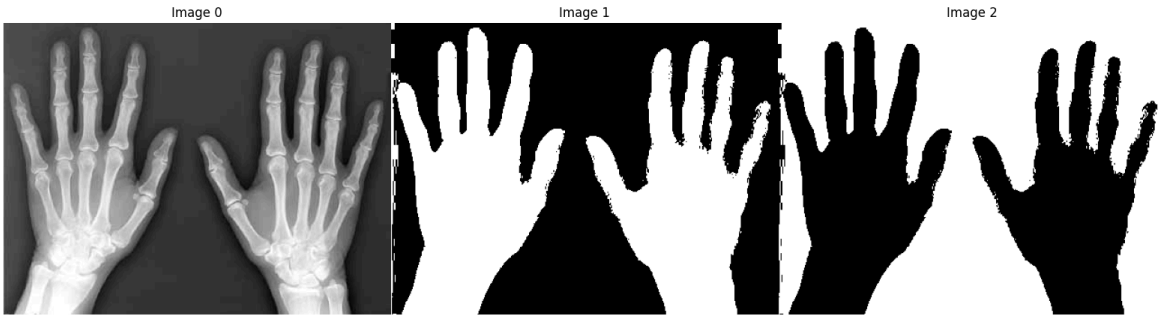

In [ ]:
```python
def otsu(gray):
  pixel_number = gray.shape[0] * gray.shape[1]
  mean_weigth = 1.0/pixel_number
  his, bins = np.histogram(gray, np.array(range(0, 256)))
  final_thresh = -1
  final_value = -1

  WBackground = []
  WForeground = []
  Values = []

  for t in bins[1:-1]: # This goes from 1 to 254 uint8 range (Pretty sure wont b
      Wb = np.sum(his[:t]) * mean_weigth
      Wf = np.sum(his[t:]) * mean_weigth

      mub = np.mean(his[:t])
      muf = np.mean(his[t:])

      value = Wb * Wf * (mub - muf) ** 2
      # print("Wb", Wb, "Wf", Wf)
      # print("t", t, "value", value)
      WBackground.append(Wb)
      WForeground.append(Wf)
```

```
        Values.append(value)

        if value > final_value:
            final_thresh = t
            final_value = value

    final_img = gray.copy()
    print(final_thresh)
    final_img[gray > final_thresh] = 255
    final_img[gray < final_thresh] = 0
    return final_img, final_thresh, [WBackground, WForeground, Values]
```

In [ ]:
```
final_img, final_thresh, parms = otsu(image_gray)
ShowImage([image_gray, final_img], 1, 2)
```

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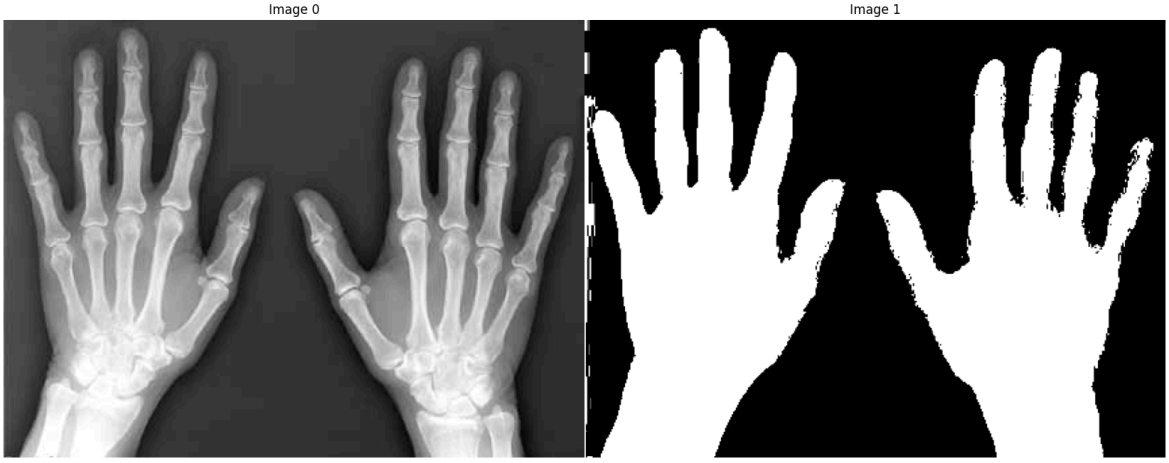

In [ ]:
```
WBackground, WForeground, Values = parms[0], parms[1], parms[2]
print(WBackground)
print(WForeground)
print(Values)

plt.plot(Values)
plt.show()
plt.plot(WBackground)
plt.plot(WForeground)
plt.show()
```

[0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 7.177203560149294e-06, 1.4355440712029859e-05, 2.1533161068044788e-05, 2.8710881424059718e-05, 5.024404249210451e-05, 9.331036462819408e-05, 0.00016508756818834337, 0.0002440424921045076, 0.00039477461958082114, 0.0006603502727533735, 0.0008756818834338214, 0.0011699684180304336, 0.0015647430376112546, 0.0019164513350559862, 0.0024834912431811657, 0.003244329600918748, 0.004163077806488659, 0.004995693367786391, 0.006302038472581108, 0.007378696525983348, 0.008678639104220 5, 0.010041630778064886, 0.011871949468848694, 0.013781223083548665, 0.016006316393913294, 0.018726672408842952, 0.021583405110536892, 0.024382716049382715, 0.02794286534596612, 0.03147430376112546, 0.0353861613551536, 0.039735859890 89865, 0.0441358024691358, 0.04908125179443009, 0.05404823428079242, 0.059788323284524835, 0.06510192362905541, 0.0709158771174275, 0.0760623026126902, 0.0843812805053115, 0.09063307493540051, 0.09997846683893195, 0.10795291415446454, 0.1249066896353718, 0.13213465403387883, 0.1573643410852713, 0.1656761412575366, 0.17433247200689062, 0.20666810221073786, 0.21463537180591444, 0.2731122595463681, 0.27989520528280215, 0.3261699684180304, 0.33354148722365773, 0.35608670686190064, 0.36021389606660925, 0.3936548952052828, 0.39729399942578236, 0.44427217915590006, 0.4494401378122308, 0.472616996841803, 0.4761125466551823, 0.4838070628768303, 0.4871805914441573, 0.4902813666379558, 0.4937194946884869, 0.4973585989089865, 0.5043640539764571, 0.5076370944587999, 0.5209517657192075, 0.5253301751363767, 0.5316968130921619, 0.5359532012632787, 0.5419609532012633, 0.5457579672695951, 0.551923629055412, 0.5554622451909274, 0.5589003732414585, 0.562051392477749, 0.5649727246626471, 0.5682457651449899, 0.5715690496698248, 0.5742894056847545, 0.5771102497846684, 0.5802469135802469, 0.5833835773758255, 0.5867571059431524, 0.589951191501579, 0.5933893195521103, 0.596662360034453, 0.5997990238300316, 0.6028495549813379, 0.6059933964972725, 0.6097832328452484, 0.6132357163364915, 0.6169250645994832, 0.6200832615561298, 0.6232055699109963, 0.6260335917312662, 0.6291630778064886, 0.6320772322710307, 0.6348908986505886, 0.6376830318690784, 0.6400157909847832, 0.6424346827447602, 0.6446597760551249, 0.6469207579672696, 0.6489592305483778, 0.6509043927648579, 0.6530146425495262, 0.654859316681022, 0.6568834338214183, 0.6586922193511341, 0.66057278208441, 0.6625394774619581, 0.6645133505598622, 0.6664298018949182, 0.6683390755096181, 0.6703488372093023, 0.6725954636807735, 0.6746339362618432, 0.6770384725811082, 0.6796583405110537, 0.6817183462532299, 0.684151593453919, 0.6864197530864198, 0.6891257536606373, 0.6920829744473155, 0.6948679299454493, 0.6977246626471433, 0.7008828596037898, 0.7036319265001435, 0.7062087281079529, 0.7092377260981912, 0.7120513924777491, 0.7150732127476314, 0.7181596325007178, 0.7215403387884007, 0.7245549813379271, 0.7278782658627619, 0.7308641975308642, 0.7345320126327878, 0.7373887453344817, 0.7403172552397358, 0.7434323858742463, 0.7467915590008612, 0.7502081538903244, 0.7534094171691 07, 0.7566393913293138, 0.7596612115991961, 0.7629127189204709, 0.7659273614699971, 0.7689563594602354, 0.7719422911283376, 0.7752799310938846, 0.7781294860752225, 0.781244616709733, 0.7840223944875108, 0.786993970714901, 0.789944013781223, 0.7932888314671 26, 0.7963465403387884, 0.7997990238300315, 0.8031151306345105, 0.8066393913293138, 0.8100057421762847, 0.8136807349985644, 0.817312661498708, 0.8207220786678151, 0.8242248062015504, 0.8276629342520815, 0.8310795291415446, 0.8344530577088717, 0.8380203847258111, 0.8414585127763422, 0.8449540625897215, 0.8483275911570485, 0.8518159632500718, 0.8551607809359747, 0.858670686190066, 0.8619293712316968, 0.8652526557565317, 0.8682026988228538, 0.8711814527706, 0.8739879414298019, 0.8771317829457365, 0.8798736721217341, 0.8826299167384438, 0.8850703416594 89, 0.8876040769451622, 0.8903100775193798, 0.8929801894918173, 0.8957651449899512, 0.8982988802756244, 0.9006029285099052, 0.9032371518805627, 0.9061800172265289, 0.9089936836060867, 0.9116063738156761, 0.9143267298306058, 0.9167240884295148, 0.9194731553258685, 0.9217341372380132, 0.92408125179443, 0.9266508756818834, 0.9289692793568762, 0.9313379270743611, 0.9338644846396784, 0.9364843525696238, 0.9388817111685328, 0.9411355153603216, 0.943755383290267, 0.9462604076945161, 0.9487582543784094, 0.9513494114269307, 0.9537037037037037, 0.956294860752225, 0.9585414872236577, 0.9612761986792995, 0.9637309790410565, 0.9662431811656618, 0.9688415159345392, 0.9711024978466839, 0.9733132357163364, 0.9753875968992248, 0.9775193798449612, 0.9795004306632213, 0.9811584840654608, 0.9830318690783807, 0.9848191214470284, 0.9869580821131209, 0.9886592018374963, 0.9910780935974735]

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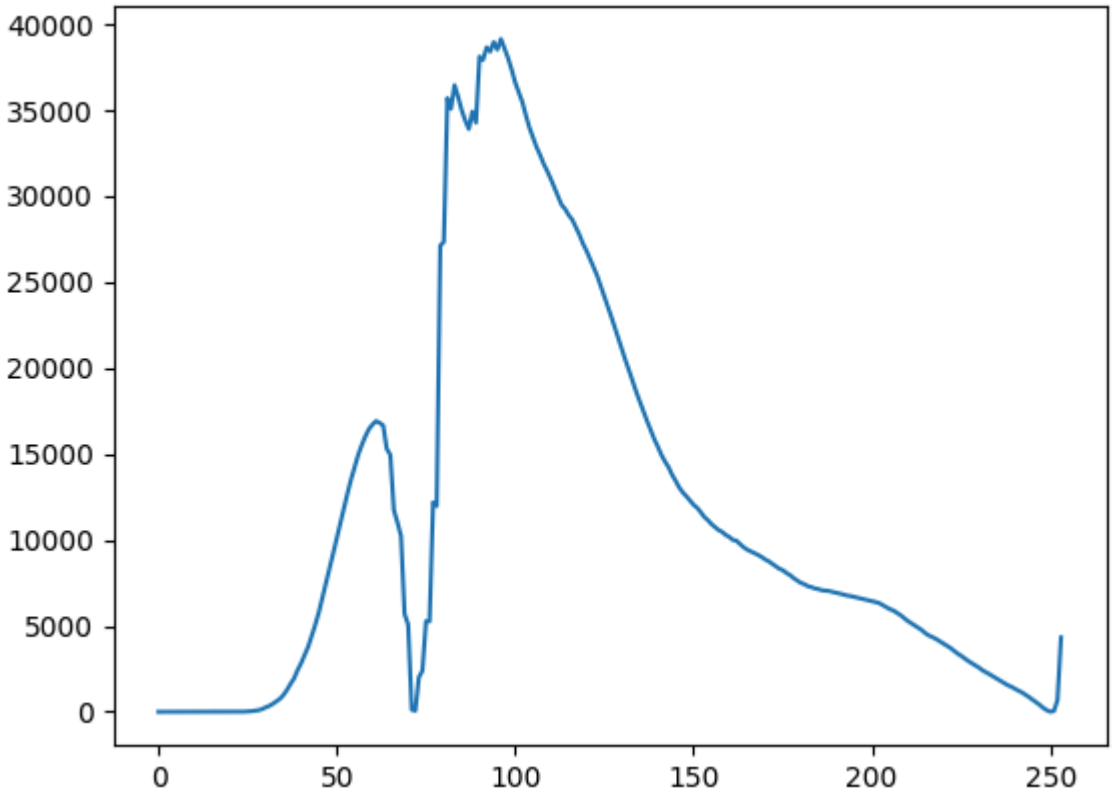
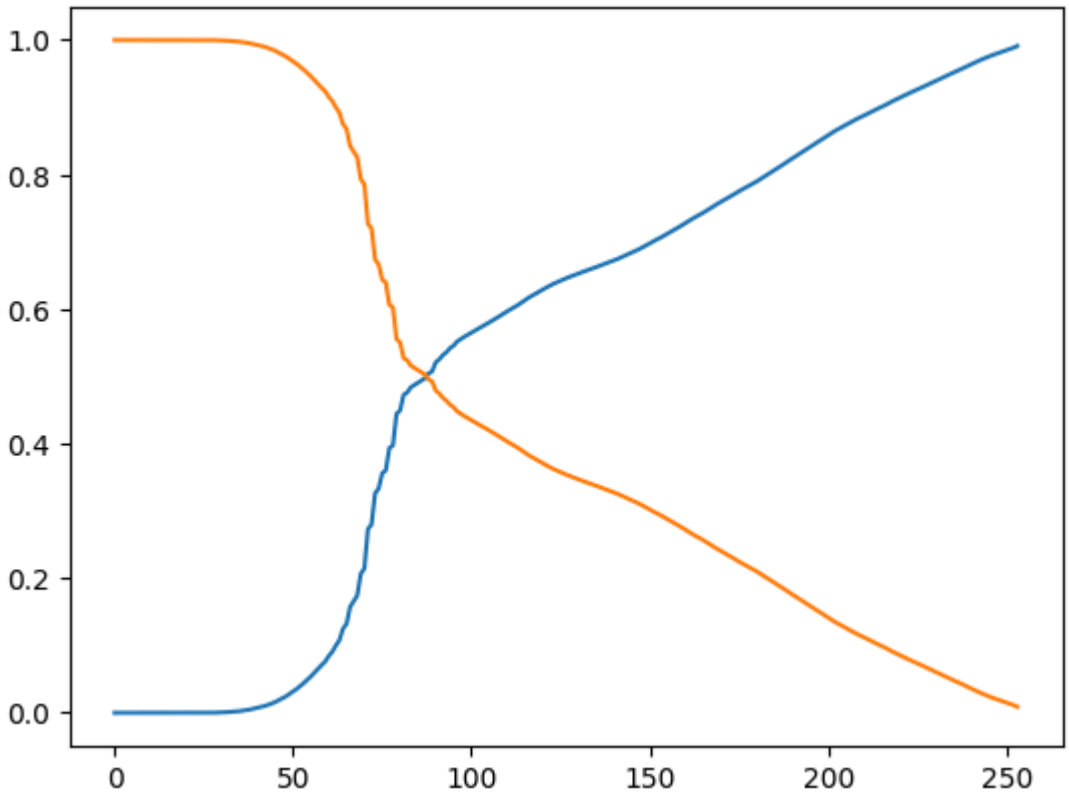
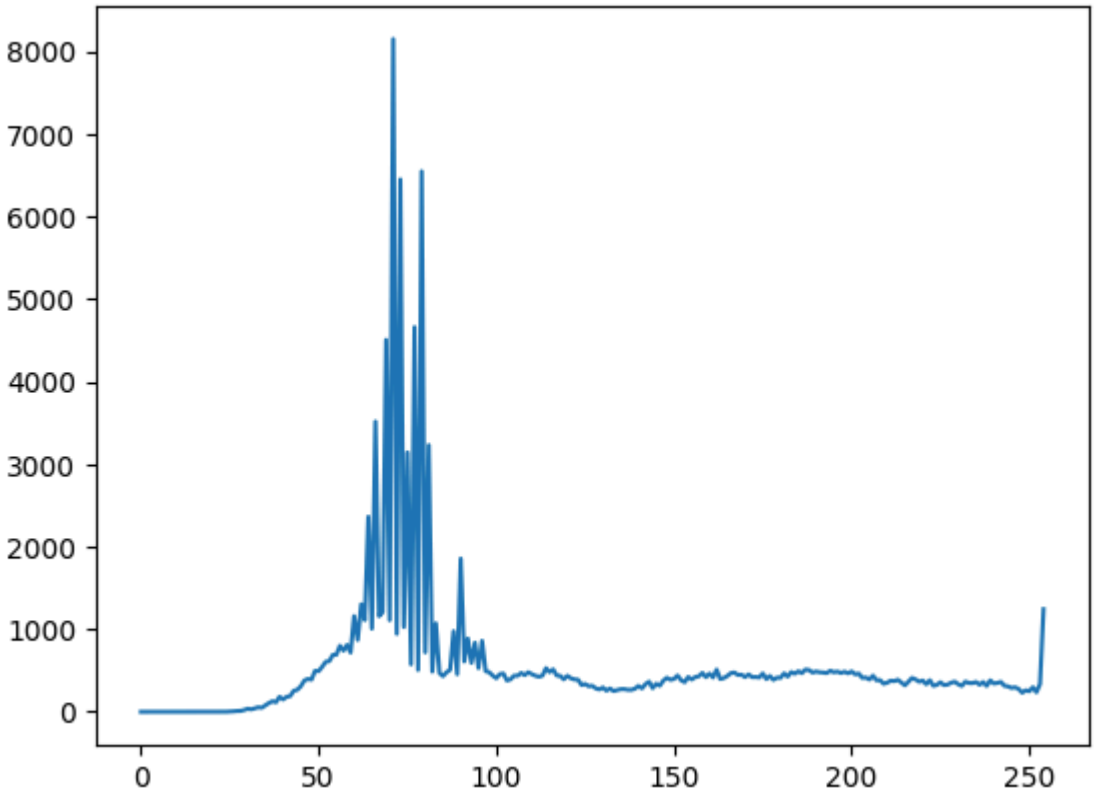


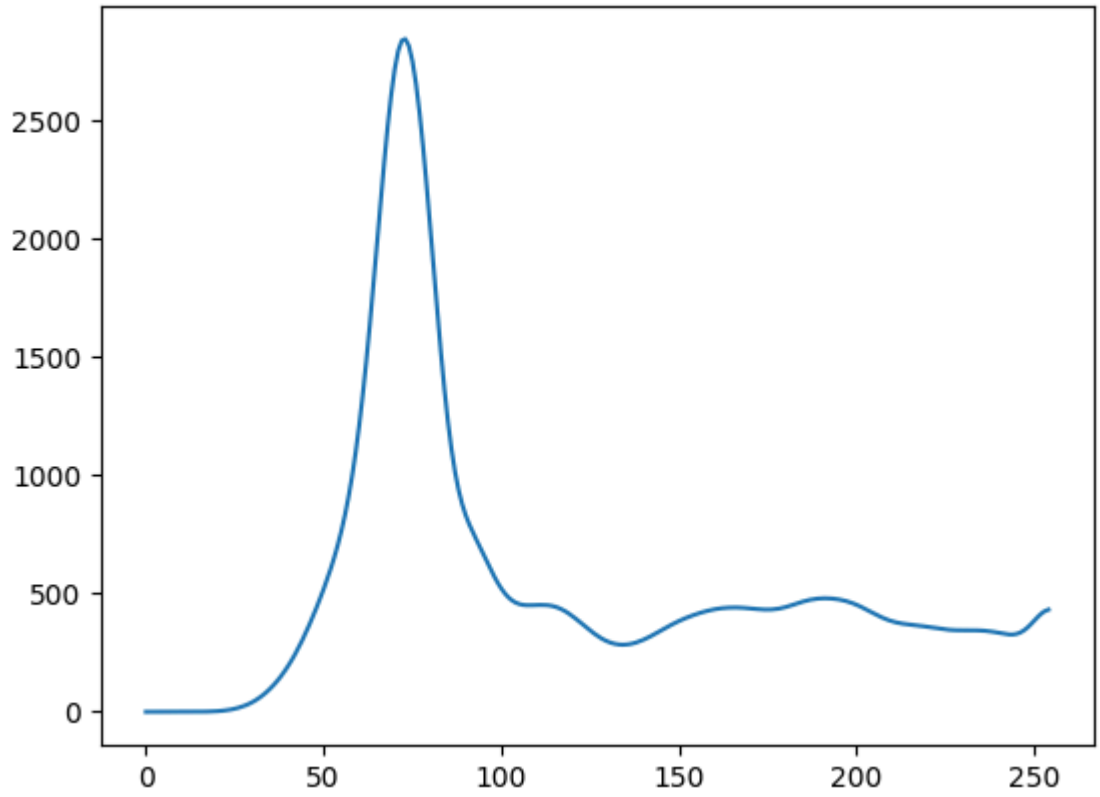


In [ ]:
```python
def two_peaks_threshold(image, smooth_hist=True, sigma=5):
    from scipy.ndimage import gaussian_filter

    hist = np.histogram(image, bins=range(256))[0].astype(np.float64)
    plt.plot(hist)
    plt.show()

    if smooth_hist:
        hist = gaussian_filter(hist, sigma=sigma)
        plt.plot(hist)
```

```
        plt.show()

    f_peak = np.argmax(hist)

    # finding second peak
    s_peak = np.argmax((np.arange(len(hist)) - f_peak) ** 2 * hist)

    thr = np.argmin(hist[min(f_peak, s_peak): max(f_peak, s_peak)])
    thr += min(f_peak, s_peak)

    final_img = image.copy()
    print(thr)
    final_img[image > thr] = 255
    final_img[image < thr] = 0

    return final_img, thr, hist
```

In [ ]:
```
final_img, final_thresh, hist = two_peaks_threshold(image_gray)
ShowImage([image_gray, final_img], 1, 2)
```





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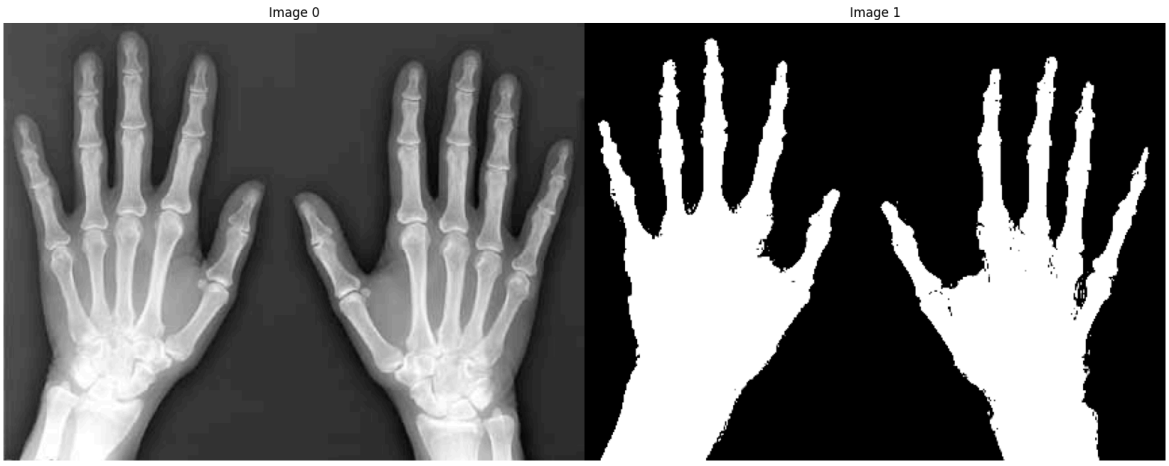
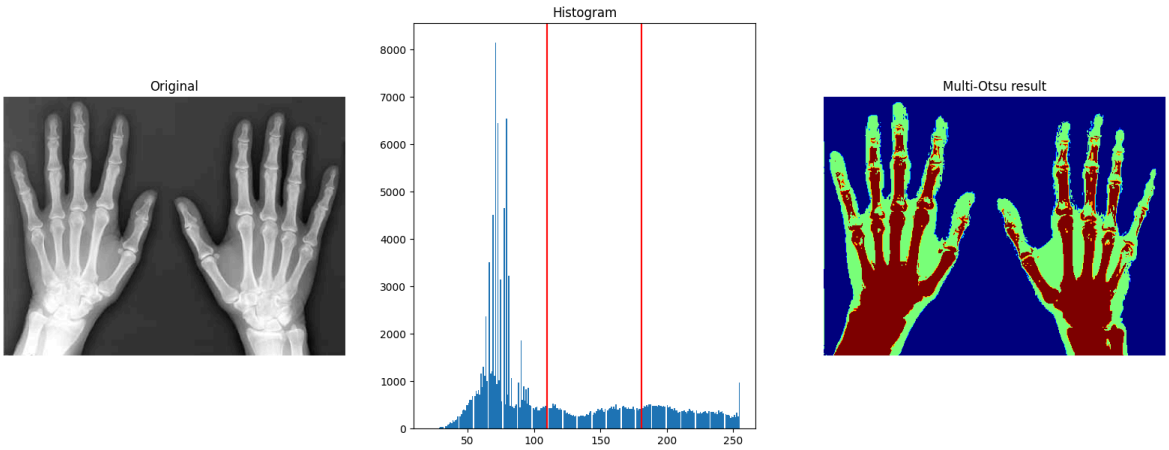


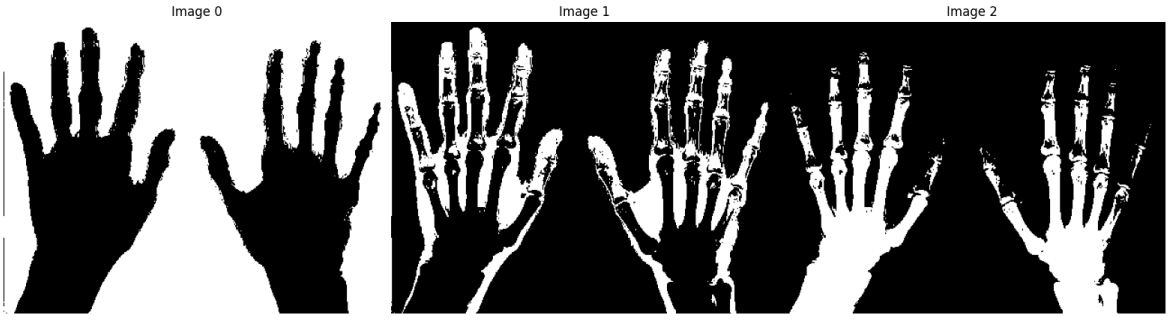
In [ ]:

```
from skimage.filters import threshold_multiotsu
# Applying multi-Otsu threshold for the default value, generating
# three classes.
thresholds = threshold_multiotsu(image_gray)
# Using the threshold values, we generate the three regions.
regions = np.digitize(image_gray, bins=thresholds)

fig, ax = plt.subplots(nrows=1, ncols=3, figsize=(20, 7))
# Plotting the original image.
ax[0].imshow(image_gray, cmap='gray')
ax[0].set_title('Original')
ax[0].axis('off')
# Plotting the histogram and the two thresholds obtained from
# multi-Otsu.
ax[1].hist(image_gray.ravel(), bins=255)
ax[1].set_title('Histogram')
for thresh in thresholds:
    ax[1].axvline(thresh, color='r')
# Plotting the Multi Otsu result.
```

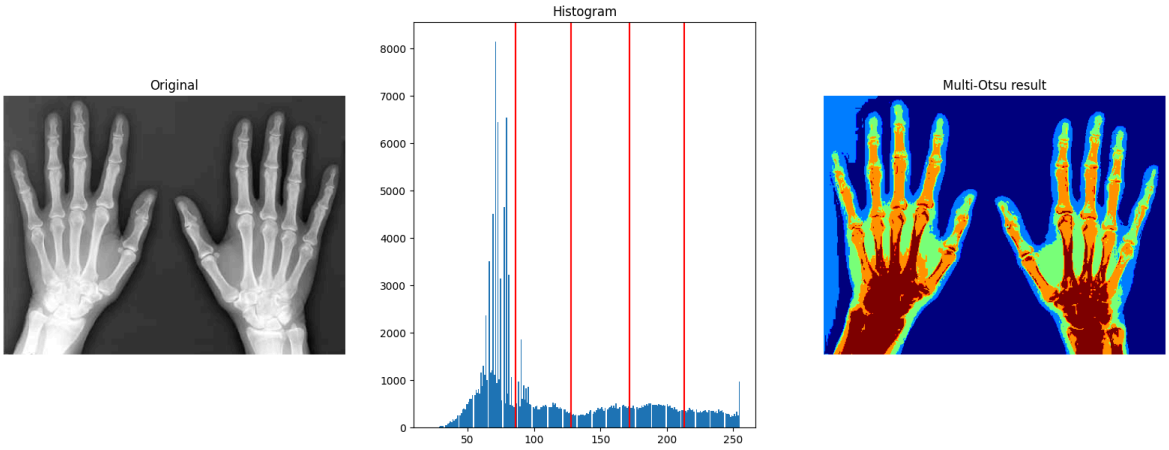
```
ax[2].imshow(regions, cmap='jet')
ax[2].set_title('Multi-Otsu result')
ax[2].axis('off')
plt.subplots_adjust()
plt.show()
```



In [ ]:
```
Segments = []
for idx in list(np.unique(regions)):
  mask = regions == idx
  Segments.append(mask)

ShowImage(Segments, 1, len(Segments))
```

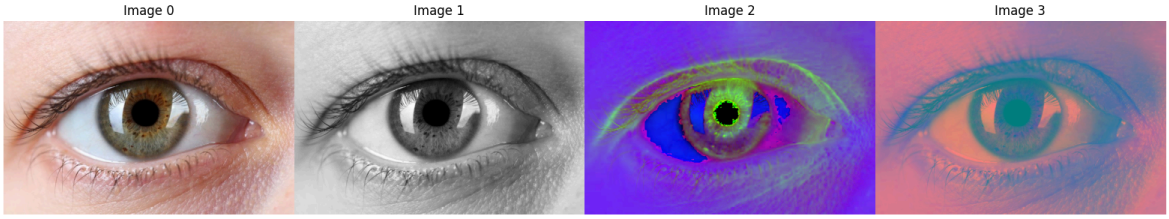


In [ ]:
```
thresholds = threshold_multiotsu(image_gray, classes=5)
regions = np.digitize(image_gray, bins=thresholds)

fig, ax = plt.subplots(nrows=1, ncols=3, figsize=(20, 7))
# Plotting the original image.
ax[0].imshow(image_gray, cmap='gray')
ax[0].set_title('Original')
ax[0].axis('off')
# Plotting the histogram and the two thresholds obtained from
# multi-Otsu.
ax[1].hist(image_gray.ravel(), bins=255)
ax[1].set_title('Histogram')
for thresh in thresholds:
    ax[1].axvline(thresh, color='r')
# Plotting the Multi Otsu result.
ax[2].imshow(regions, cmap='jet')
ax[2].set_title('Multi-Otsu result')
ax[2].axis('off')
plt.subplots_adjust()
plt.show()
```



In [ ]:
```
FileName = 'Iris.jpg'
idx = NameDB.index(FileName)
print("Selected Image : ", "\nIndex ", idx, "\nName ", NameDB[idx])

image_orig = ImageDB[idx]
image_orig = cv2.cvtColor(image_orig,cv2.COLOR_BGR2RGB)
image_gray = cv2.cvtColor(image_orig,cv2.COLOR_BGR2GRAY)
image_hsv = cv2.cvtColor(image_orig, cv2.COLOR_BGR2HSV)
image_ycbcr = cv2.cvtColor(image_orig, cv2.COLOR_BGR2YCR_CB)
ShowImage([image_orig, image_gray, image_hsv, image_ycbcr], 1, 4)
```

```
Selected Image :
Index  17
Name  Iris.jpg
```

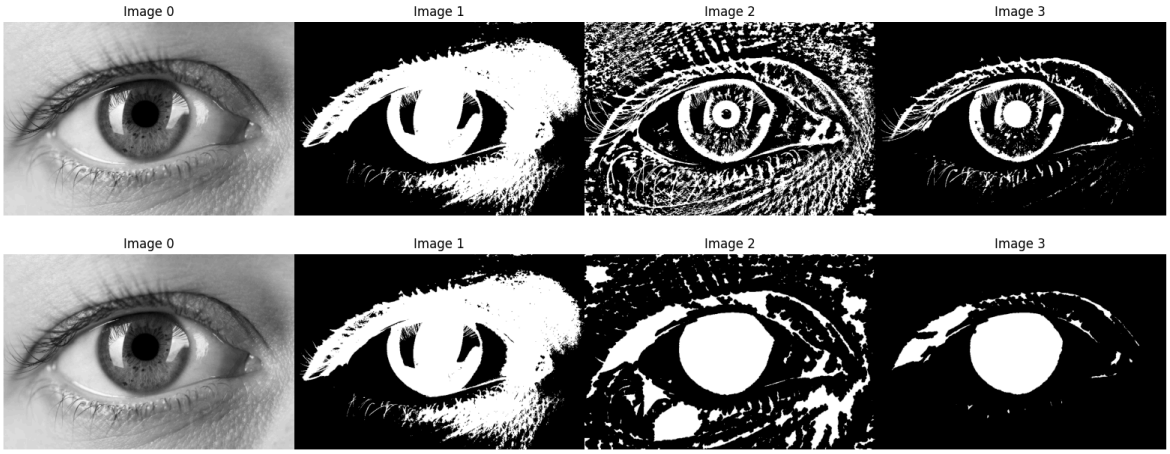


In [ ]:
```
from scipy import ndimage as ndi
def FillHoles(Mask):
  Result = ndi.binary_fill_holes(Mask)
  return Result
```

In [ ]:
```
def SelectLargestRegion(Mask):
  import pandas as pd
  from skimage.measure import label, regionprops

  mask = Mask.copy()
  mask_output = mask * 0
  label_img = label(mask)
  regions = regionprops(label_img)
  max_area = 0
  ilabel = 0
  for props in regions:
    area = props.area
    if(area > max_area):
      max_area = area
      ilabel = props.label

  mask_output = mask_output + (label_img == ilabel).astype(int)
  return mask_output
```

In [ ]:
```
def morphology(Mask, Size):
  from skimage.morphology import erosion, dilation, opening, closing, white_toph
  from skimage.morphology import disk
  selem = disk(abs(Size))
  if(Size > 0):
      result = dilation(Mask, selem)
  else:
      result = erosion(Mask, selem)
  return result
```

In [ ]:
```
from skimage.filters import (threshold_otsu, threshold_niblack, threshold_sauvol
image = image_gray
binary_global = image < threshold_otsu(image)

thresh_niblack = threshold_niblack(image, window_size=45)
thresh_sauvola = threshold_sauvola(image, window_size=45)

binary_niblack = image < thresh_niblack
binary_sauvola = image < thresh_sauvola

ShowImage([image, binary_global, binary_niblack, binary_sauvola], 1, 4)

binary_niblack = FillHoles(binary_niblack)
binary_sauvola = FillHoles(binary_sauvola)

binary_niblack = morphology(binary_niblack, -3)
binary_sauvola = morphology(binary_sauvola, -3)

ShowImage([image, binary_global, binary_niblack, binary_sauvola], 1, 4)
```



In [ ]:
```
def SegmentColorImageByMask(IM, Mask):
    Mask = Mask.astype(np.uint8)
    result = cv2.bitwise_and(IM, IM, mask = Mask)
    return result
```

In [ ]:
```
binary_niblack_segmentation = SelectLargestRegion(binary_niblack)
binary_sauvola_segmentation = SelectLargestRegion(binary_sauvola)

ShowImage([image, binary_niblack_segmentation, binary_niblack_segmentation], 1,

binary_niblack_color = SegmentColorImageByMask(image_orig, binary_niblack_segmen
binary_sauvola_color = SegmentColorImageByMask(image_orig, binary_sauvola_segmen

ShowImage([image_orig, binary_niblack_color, binary_sauvola_color], 1, 4)
```

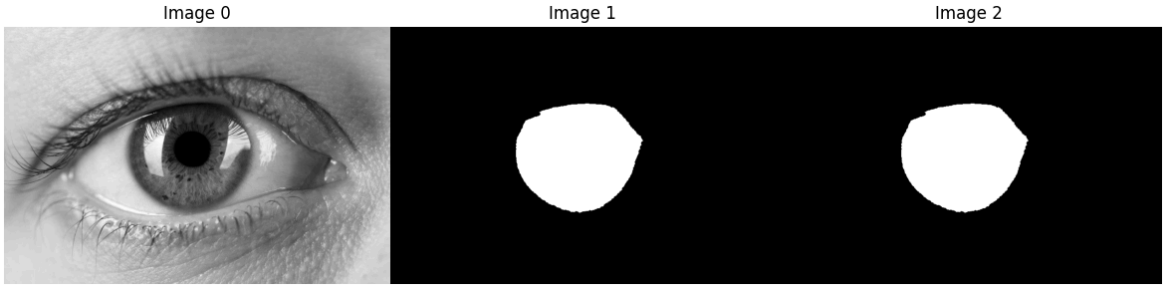


Image 0
Image 1
Image 2

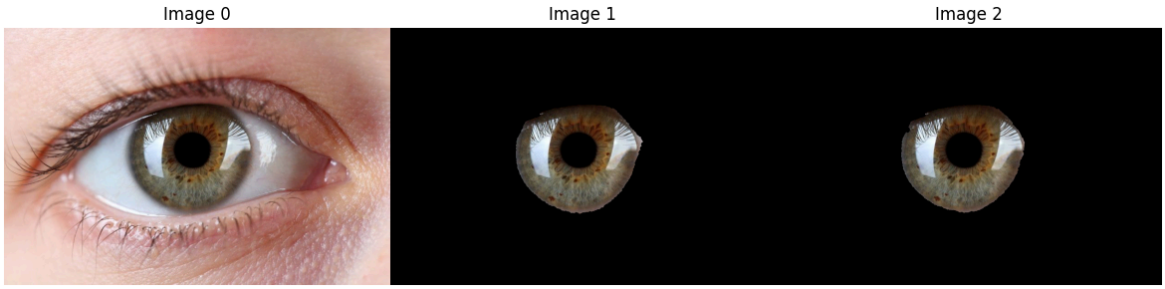


Image 0
Image 1
Image 2