Instructions

Follow the instructions given in comments prefixed with ## and write your code below that.

Also fill the partial code in given blanks.

Don't make any changes to the rest part of the codes

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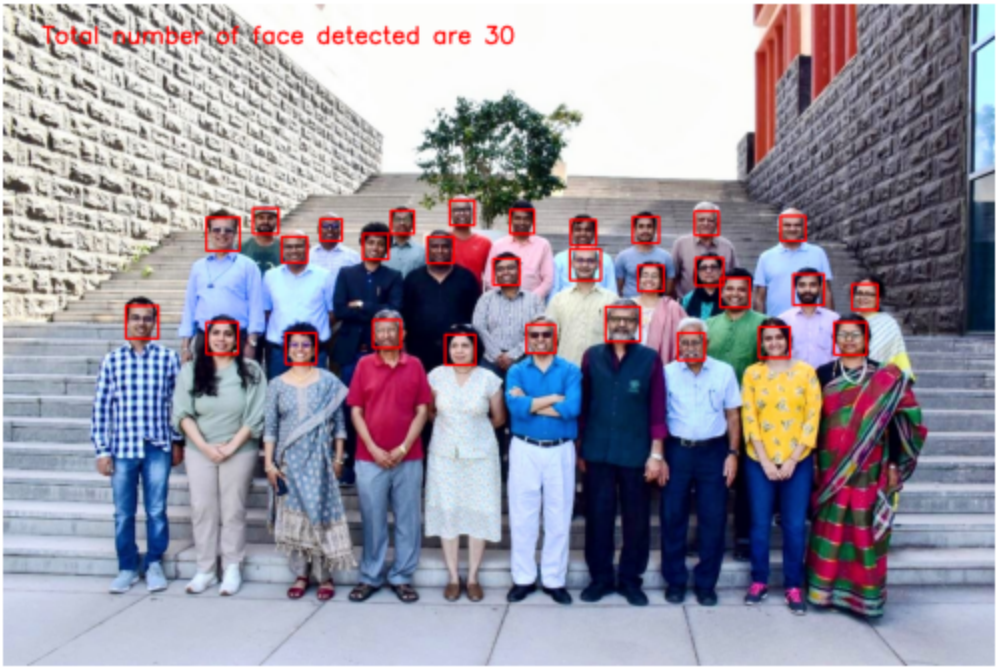
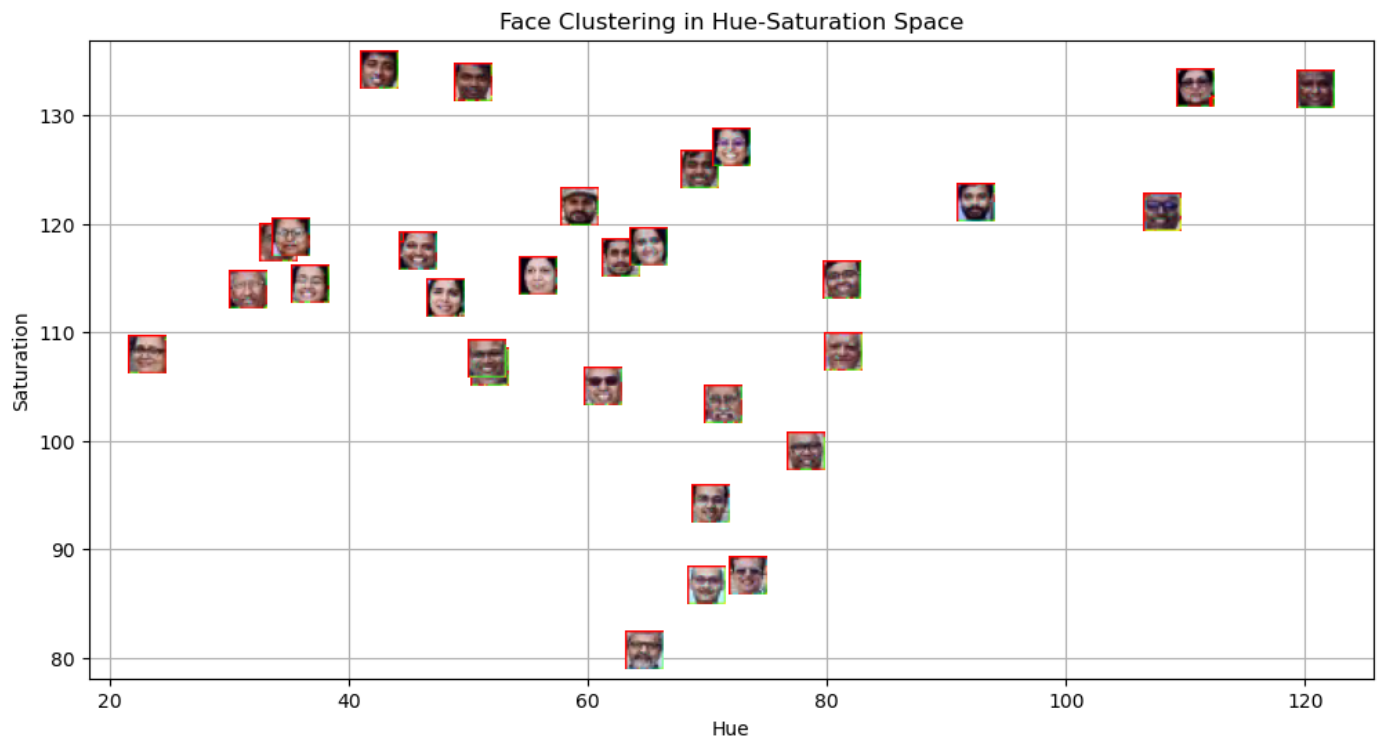
In [1]:
```
import cv2
import numpy as np
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans
from scipy.spatial import distance
from matplotlib.offsetbox import OffsetImage, AnnotationBbox
import warnings
warnings.filterwarnings('ignore')
```

In [2]:
```
# Read the image plaksha_Faculty.jpg
img = cv2.imread('plaksha_Faculty.jpg')

# Convert the image to grayscale
gray_img = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

# Loading the Haar cascade xml classifier for face detection
face_cascade = cv2.CascadeClassifier('haarcascade_frontalface_default.xml')

# Applying the face detection method on the grayscale image
faces_rect = face_cascade.detectMultiScale(gray_img, 1.05, 4, minSize=(25, 25), maxSize=

# Define the text and font parameters
text = "Total number of face detected are {}".format(len(faces_rect))
font = cv2.FONT_HERSHEY_SIMPLEX
font_scale = 1
font_color = (0, 0, 255)  # Red color in BGR
font_thickness = 2

# Iterating through rectangles of detected faces
for (x, y, w, h) in faces_rect:
    cv2.rectangle(img, (x, y), (x + w, y + h), (0, 0, 255), 2)
    # Adding the text to the image
    cv2.putText(img, text, (50, 50), font, font_scale, font_color, font_thickness)

# Convert BGR to RGB for displaying with matplotlib
img_rgb = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)

# Display the image using matplotlib
plt.imshow(img_rgb)
plt.axis('off')  # Hide axis numbers and ticks
plt.show()
```



In [3]:

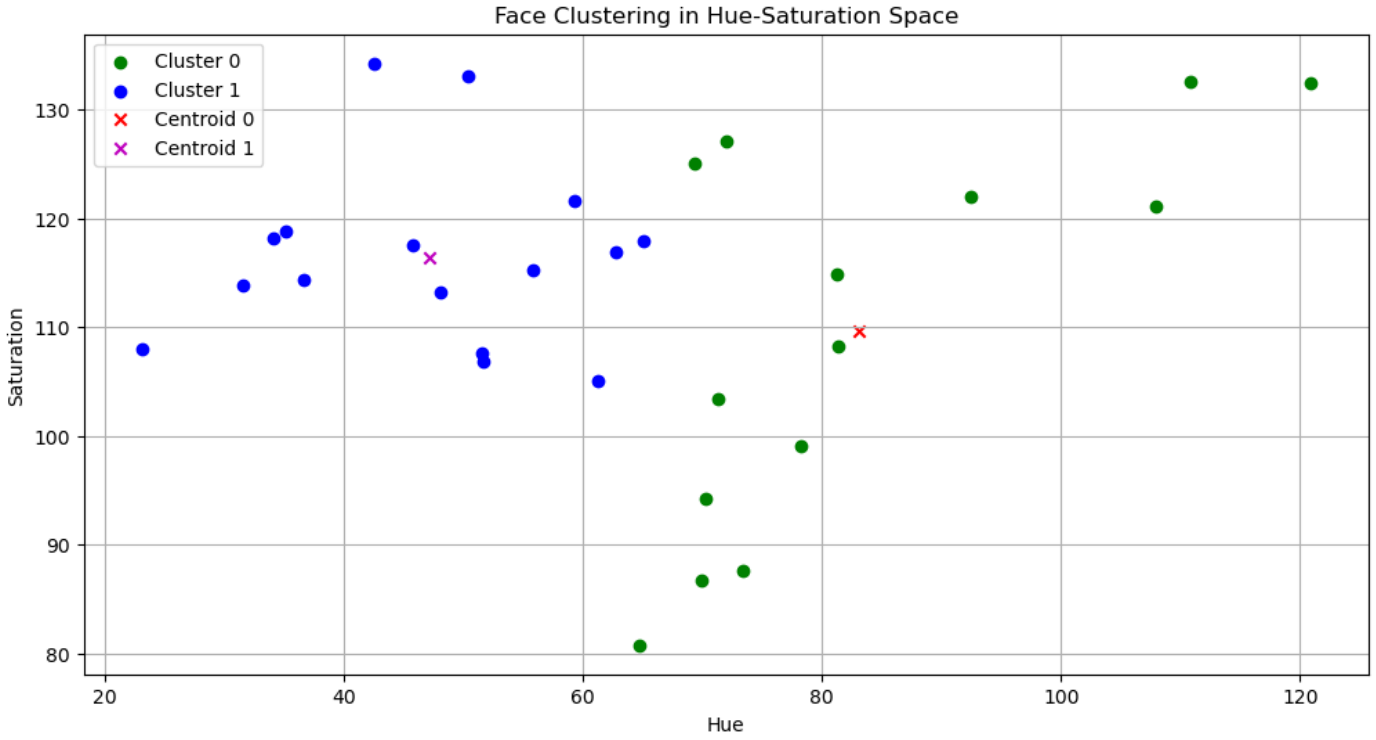
```
from matplotlib.offsetbox import OffsetImage, AnnotationBbox

# Extract face region features (Hue and Saturation)
img_hsv = cv2.cvtColor(img, cv2.COLOR_BGR2HSV)  # Convert from BGR to HSV and store in i
hue_saturation = []
face_images = []  # To store detected face images

for (x, y, w, h) in faces_rect:
    face = img_hsv[y:y + h, x:x + w]
    hue = np.mean(face[:, :, 0])
    saturation = np.mean(face[:, :, 1])
    hue_saturation.append((hue, saturation))
    face_images.append(face)

hue_saturation = np.array(hue_saturation)

# Perform k-Means clustering on hue_saturation and store in kmeans
num_clusters = 2  # Adjust the number of clusters as needed
kmeans = KMeans(n_clusters=num_clusters, random_state=0).fit(hue_saturation)

# Create a figure and axis
fig, ax = plt.subplots(figsize=(12, 6))

# Plot the clustered faces with custom markers
for i, (x, y, w, h) in enumerate(faces_rect):
    im = OffsetImage(cv2.cvtColor(cv2.resize(face_images[i], (20, 20)), cv2.COLOR_HSV2RG
    ab = AnnotationBbox(im, (hue_saturation[i, 0], hue_saturation[i, 1]), frameon=False,
    ax.add_artist(ab)
    plt.plot(hue_saturation[i, 0], hue_saturation[i, 1])  # Plotting the points

# Set labels and title
plt.xlabel('Hue')
plt.ylabel('Saturation')
plt.title('Face Clustering in Hue-Saturation Space')

# Display the grid
plt.grid(True)

# Show the plot
plt.show()
```



In [4]:

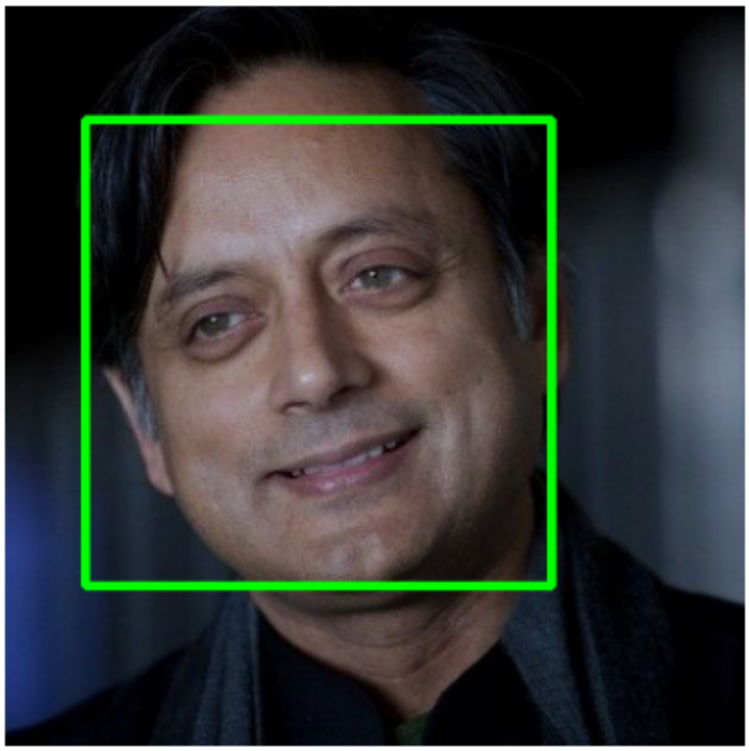
```
# Create an empty list to store legend labels
legend_labels = []

# Create lists to store points for each cluster
cluster_0_points = []
cluster_1_points = []

# Your code for scatter plot goes here
fig, ax = plt.subplots(figsize=(12, 6))
for i, (x, y, w, h) in enumerate(faces_rect):
    if kmeans.labels_[i] == 0:
        cluster_0_points.append((hue_saturation[i, 0], hue_saturation[i, 1]))
    else:
        cluster_1_points.append((hue_saturation[i, 0], hue_saturation[i, 1]))

cluster_0_points = np.array(cluster_0_points)
# Plot points for cluster 0 in green
plt.scatter(cluster_0_points[:, 0], cluster_0_points[:, 1], c='g', label='Cluster 0')

cluster_1_points = np.array(cluster_1_points)
# Plot points for cluster 1 in blue
plt.scatter(cluster_1_points[:, 0], cluster_1_points[:, 1], c='b', label='Cluster 1')

# Calculate and plot centroids
centroid_0 = np.mean(cluster_0_points, axis=0)
centroid_1 = np.mean(cluster_1_points, axis=0)

# Plot both the centroid for cluster 0 and cluster 1
plt.scatter(centroid_0[0], centroid_0[1], c='r', marker='x', label='Centroid 0')
plt.scatter(centroid_1[0], centroid_1[1], c='m', marker='x', label='Centroid 1')

# Set labels and title
plt.xlabel('Hue')
plt.ylabel('Saturation')
plt.title('Face Clustering in Hue-Saturation Space')

# Add a legend
plt.legend()

# Display the grid
plt.grid(True)
```

```
# Show the plot
plt.show()
```



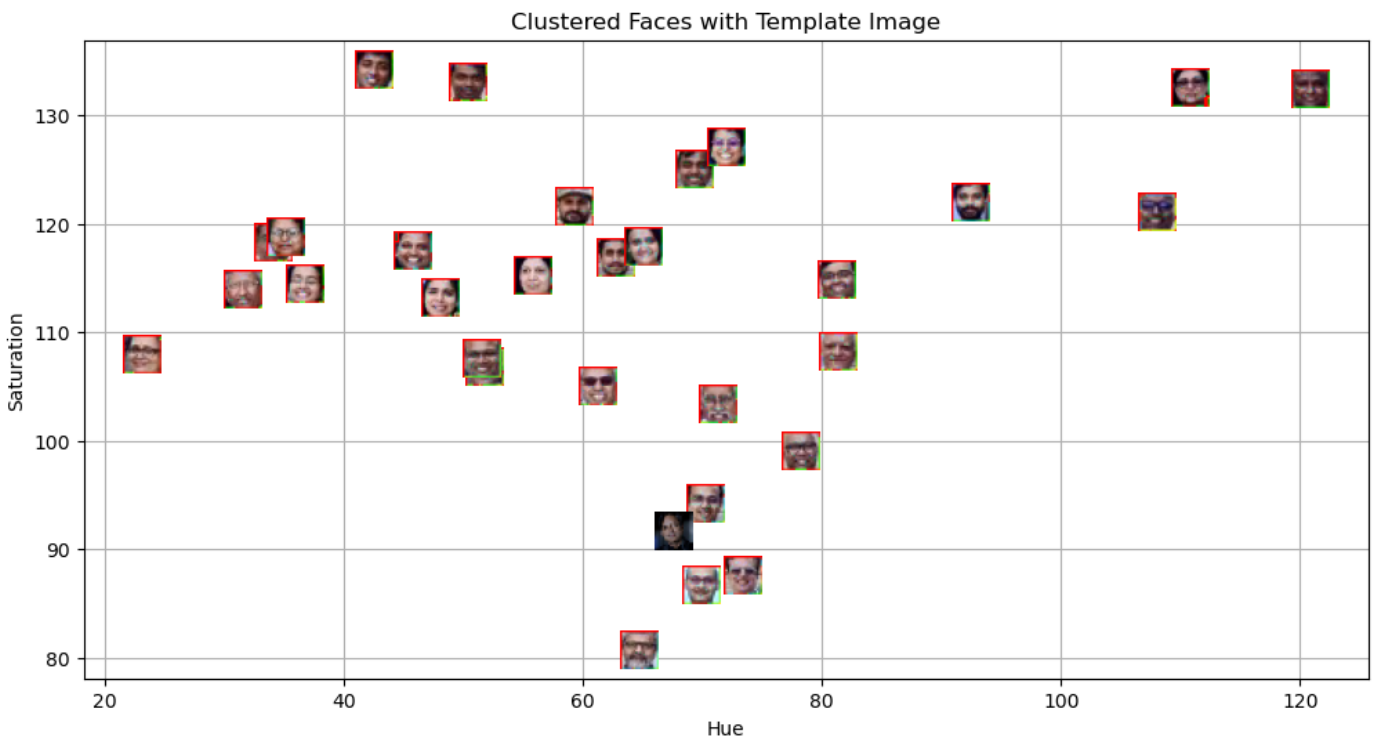
In [5]:

```
# Read the template image 'Dr_Shashi_Tharoor.jpg' using cv2
template_img = cv2.imread('Shashi_Tharoor.jpeg')

# Convert the template image to grayscale
template_gray = cv2.cvtColor(template_img, cv2.COLOR_BGR2GRAY)

# Load the face cascade classifier
face_cascade = cv2.CascadeClassifier('haarcascade_frontalface_default.xml')

# Detect faces in the template image
template_faces = face_cascade.detectMultiScale(template_gray, 1.05, 4, minSize=(25, 25),

# Draw rectangles around the detected faces
for (x, y, w, h) in template_faces:
    cv2.rectangle(template_img, (x, y), (x + w, y + h), (0, 255, 0), 3)

# Convert BGR to RGB for displaying with matplotlib
template_img_rgb = cv2.cvtColor(template_img, cv2.COLOR_BGR2RGB)

# Display the image using matplotlib
plt.imshow(template_img_rgb)
plt.axis('off')  # Hide axis numbers and ticks
plt.show()
```



In [6]:

```
# Convert the template image to HSV color space
template_hsv = cv2.cvtColor(template_img, cv2.COLOR_BGR2HSV)

# Extract hue and saturation features from the template image
template_hue = np.mean(template_hsv[:, :, 0])
template_saturation = np.mean(template_hsv[:, :, 1])

# Predict the cluster label for the template image
template_label = kmeans.predict([[template_hue, template_saturation]])

# Create a figure and axis for visualization
fig, ax = plt.subplots(figsize=(12, 6))

# Plot the clustered faces with custom markers (similar to previous code)
for i, (x, y, w, h) in enumerate(faces_rect):
    color = 'red' if kmeans.labels_[i] == 0 else 'blue'
    im = OffsetImage(cv2.cvtColor(cv2.resize(face_images[i], (20, 20)), cv2.COLOR_HSV2RG
    ab = AnnotationBbox(im, (hue_saturation[i, 0], hue_saturation[i, 1]), frameon=False,
    ax.add_artist(ab)
    plt.plot(hue_saturation[i, 0], hue_saturation[i, 1], 'o', markersize=5, color=color)

# Plot the template image in the respective cluster
if template_label == 0:
    color = 'red'
else:
    color = 'blue'
im = OffsetImage(cv2.cvtColor(cv2.resize(template_img, (20, 20)), cv2.COLOR_BGR2RGB))
ab = AnnotationBbox(im, (template_hue, template_saturation), frameon=False, pad=0)
ax.add_artist(ab)

# Add x label
plt.xlabel('Hue')
# Add y label
plt.ylabel('Saturation')
# Add title
plt.title('Clustered Faces with Template Image')
# Add grid
plt.grid(True)
# Show the plot
plt.show()
```



In [7]:

```
# Create an empty list to store legend labels
legend_labels = []

# Create lists to store points for each cluster
cluster_0_points = []
cluster_1_points = []

# Your code for scatter plot goes here
fig, ax = plt.subplots(figsize=(12, 6))
for i, (x, y, w, h) in enumerate(faces_rect):
    if kmeans.labels_[i] == 0:
        cluster_0_points.append((hue_saturation[i, 0], hue_saturation[i, 1]))
    else:
        cluster_1_points.append((hue_saturation[i, 0], hue_saturation[i, 1]))

cluster_0_points = np.array(cluster_0_points)
plt.scatter(cluster_0_points[:, 0], cluster_0_points[:, 1], c='green', label='Cluster 0'

# Plot points for cluster 1 in blue
cluster_1_points = np.array(cluster_1_points)
plt.scatter(cluster_1_points[:, 0], cluster_1_points[:, 1], c='blue', label='Cluster 1')

# Calculate and plot centroids for both clusters
centroid_0 = np.mean(cluster_0_points, axis=0)
centroid_1 = np.mean(cluster_1_points, axis=0)
plt.scatter(centroid_0[0], centroid_0[1], c='red', marker='x', s=200, label='Centroid 0'
plt.scatter(centroid_1[0], centroid_1[1], c='purple', marker='x', s=200, label='Centroid

# Plot the marker for the template image
plt.plot(template_hue, template_saturation, marker='o', c='violet', markersize=10, label

# Add x label
plt.xlabel('Hue')
# Add y label
plt.ylabel('Saturation')
# Add title
plt.title('Clustered Faces with Template Image')
# Add a legend
plt.legend()
# Add grid
plt.grid(True)
```

```
# Show the plot
plt.show()
```