Image Process and Machine Learning

Dataset in use: [https://www.kaggle.com/datasets/cashutosh/gender-classification-dataset/data (https://www.kaggle.com/datasets/cashutosh/gender-classification-dataset/data)](https://www.kaggle.com/datasets/cashutosh/gender-classification-dataset/data)

In [1]:

```
import os
import cv2
import random
import pickle
import logging
import numpy as np
from tqdm import tqdm
from sklearn import metrics
from skimage import feature
from sklearn.svm import SVC
import matplotlib.pyplot as plt
```

In [2]:

```
import warnings
warnings.filterwarnings("ignore")
```

In [3]:

```
def metric_report(actual, predicted):
    acc = metrics.accuracy_score(actual, predicted)
    precision = metrics.precision_score(actual, predicted)
    recall = metrics.recall_score(actual, predicted)
    f1 = metrics.f1_score(actual, predicted)
    return (acc, precision, recall, f1)
```

In [4]:

```
ext='jpg'
```

In [5]:

```
def image_reader(file_path, in_use, ext=ext):

    images = []

    files = os.listdir(file_path)
    random.shuffle(files)

    files = files[:int(len(files)*in_use)]

    for file in tqdm(files, desc = 'Reading Images'):
        if file.endswith(ext):
            img_path = os.path.join(file_path, file)
            img = cv2.imread(img_path, 0)
            images.append(img)

    return images
```

In [6]:

```
male_dir = './dataset/Training/male'
female_dir = './dataset/Training/female'

male_test_dir = './dataset/Validation/male'
female_test_dir = './dataset/Validation/female'
```

In [7]:
```
train_male_images = image_reader(male_dir, 0.25)
train_female_images = image_reader(female_dir, 0.25)
```

```
Reading Images: 100%|██████████████████████████████████████████████████| 5
941/5941 [00:12<00:00, 492.70it/s]
Reading Images: 100%|██████████████████████████████████████████████████| 5
810/5810 [00:12<00:00, 465.45it/s]
```

In [8]:
```
test_male_images = image_reader(male_test_dir, 0.1)
test_female_images = image_reader(female_test_dir, 0.1)
```

```
Reading Images: 100%|████████████████████████████████████████████████████|
580/580 [00:01<00:00, 394.67it/s]
Reading Images: 100%|████████████████████████████████████████████████████|
584/584 [00:01<00:00, 328.43it/s]
```

Histogram of Oriented Gradients

In [9]:
```
hog = cv2.HOGDescriptor()
```

In [10]:
```
def hog_pattern_extractor(desc: cv2.HOGDescriptor, images, gender, ext=ext,
    data = []
    labels = []

    for img in tqdm(images):
        img_resized = cv2.resize(img, r_shape)

        hist = hog.compute(img_resized)
        hist = hist.flatten()

        data.append(hist)
        labels.append(gender)

    return data, labels
```

In [11]:
```
def hog_detector(model, target_images, gender, ext=ext, r_shape=(64, 128)):

    actual, predicted = [], []
    for img in tqdm(target_images, desc='SVM Inference'):
        img_resized = cv2.resize(img, r_shape)

        hist = hog.compute(img_resized)
        hist = hist.flatten()

        pred = model.predict(hist.reshape(1, -1))[0]
        actual.append(gender)
        predicted.append(pred)

    return actual, predicted
```

In [12]:
```
def hog_predict(model_instance, target, r_shape=(64, 128)):

    if os.path.isfile(target): logging.debug(f"{target} is a single image.")

    img_resized = cv2.resize(target, r_shape)
    hist = hog.compute(img_resized)
    hist = hist.flatten()

    pred = model_instance.predict(hist.reshape(1, -1))[0]
    return pred
```

In [13]:
```
data_hog_male, labels_hog_male = hog_pattern_extractor(hog, train_male_image
data_hog_female, labels_hog_female = hog_pattern_extractor(hog, train_female
```

```
100%|████████████████████████████████████████████████| 59
41/5941 [00:01<00:00, 4439.48it/s]
100%|████████████████████████████████████████████████| 58
10/5810 [00:01<00:00, 4422.32it/s]
```

In [14]:
```
data = np.vstack((data_hog_male, data_hog_female))
labels = np.hstack((labels_hog_male, labels_hog_female))
```

In [15]:
```
model_hog = SVC(kernel='linear', random_state=42)
model_hog.fit(data, labels)
```

Out[15]:
```
▾            SVC          i ?
                          (https://scikit-
                          learn.org/1.4/modules/generated/sklearn.svm.SVC.h
 SVC(kernel='linear', random_state=42)
```

In [16]:
```
actual_m, predicted_m = hog_detector(model_hog, test_male_images, 0)
actual_f, predicted_f = hog_detector(model_hog, test_female_images, 1)
```

```
SVM Inference: 100%|████████████████████████████████████████|
580/580 [00:04<00:00, 129.63it/s]
SVM Inference: 100%|████████████████████████████████████████|
584/584 [00:04<00:00, 142.42it/s]
```

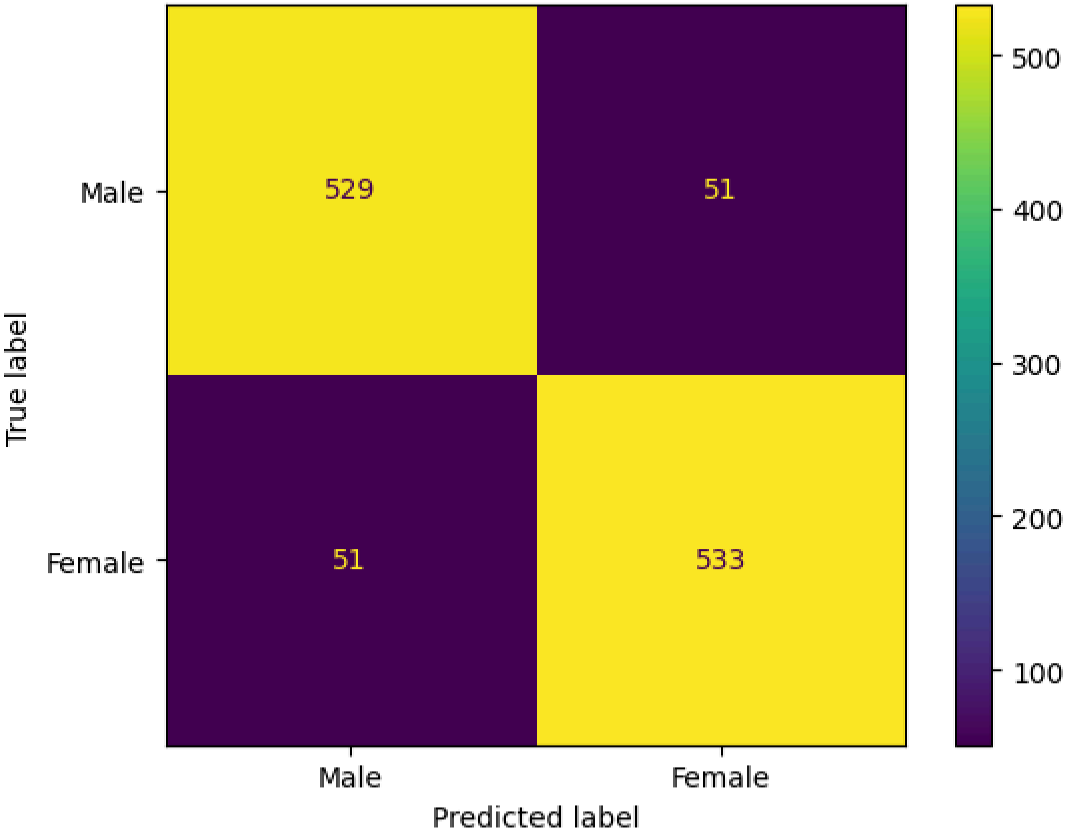
In [17]:
```
actual = np.hstack((actual_m, actual_f))
predicted = np.hstack((predicted_m, predicted_f))
```

In [18]:
```
metric_report(actual, predicted)
```

Out[18]:
```
(0.9123711340206185,
 0.9126712328767124,
 0.9126712328767124,
 0.9126712328767124)
```

In [19]:
```
confusion_matrix = metrics.confusion_matrix(actual, predicted)
```

In [20]:
```
cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix = confusion_mat
cm_display.plot()
plt.show()
```



In [21]:
```
fname = 'hog_svm_model.sav'
# pickle.dump(model_hog, open(fname, 'wb'))
```

In [22]:
```
loaded_model = pickle.load(open(fname, 'rb'))
```

In [23]:
```
# Asagidaki img_path degiskenine istenen goruntulerin pathi verilir ve hog i

img_path = './test_images/064943.jpg.jpg'
img = cv2.imread(img_path, 0)
actual = int(os.path.basename(img_path).startswith('1'))

pred = hog_predict(loaded_model, img)

if actual == pred:
    print('Gender Detected!')
```

```
Gender Detected!
```

Local Binary Patterns

In [24]:
```
class LocalBinaryPatterns:
    def __init__(self, numPoints, radius):
        self.numPoints = numPoints
        self.radius = radius

    def describe(self, image, eps=1e-7):
        lbp = feature.local_binary_pattern(image, self.numPoints, self.radiu
        (hist, _) = np.histogram(lbp.ravel(),
                                 bins=np.arange(0, self.numPoints + 3),
                                 range=(0, self.numPoints + 2))

        hist = hist.astype("float")
        hist /= (hist.sum() + eps)
        return hist
```

In [25]:
```
def lbp_detector(model, target_images, gender, ext=ext):

    actual, predicted = [], []
    for img in tqdm(target_images, desc='SVM Inference'):
        hist = desc.describe(img)

        pred = model.predict(hist.reshape(1, -1))[0]
        actual.append(gender)
        predicted.append(pred)

    return actual, predicted
```

In [26]:
```
def lbp_predict(model_instance, target):

    hist = desc.describe(target)
    hist = hist.flatten()

    pred = model_instance.predict(hist.reshape(1, -1))[0]
    return pred
```

In [27]:
```
desc = LocalBinaryPatterns(20, 5)
```

In [28]:
```
male_histograms = np.load('male_lbp_histograms.npy')
female_histograms = np.load('female_lbp_histograms.npy')
```

In [29]:
```
data = np.vstack((male_histograms, female_histograms))
labels = np.hstack( (np.zeros(len(male_histograms)), np.ones(len(female_hist
```

In [30]:
```
model_lbp = SVC(kernel='linear', random_state=42)
model_lbp.fit(data, labels)
```

Out[30]:
```
▾                SVC          i ?
                              (https://scikit-
                              learn.org/1.4/modules/generated/sklearn.svm.SVC.l
SVC(kernel='linear', random_state=42)
```

In [31]:

```
actual_m, predicted_m = lbp_detector(model_lbp, test_male_images, 0)
actual_f, predicted_f = lbp_detector(model_lbp, test_female_images, 1)
```

```
SVM Inference: 100%|██████████████████████████████████████████████████|
580/580 [00:03<00:00, 174.89it/s]
SVM Inference: 100%|██████████████████████████████████████████████████|
584/584 [00:03<00:00, 171.71it/s]
```

In [32]:

```
actual = np.hstack((actual_m, actual_f))
predicted = np.hstack((predicted_m, predicted_f))
```

In [33]:

```
metric_report(actual, predicted)
```

Out[33]:

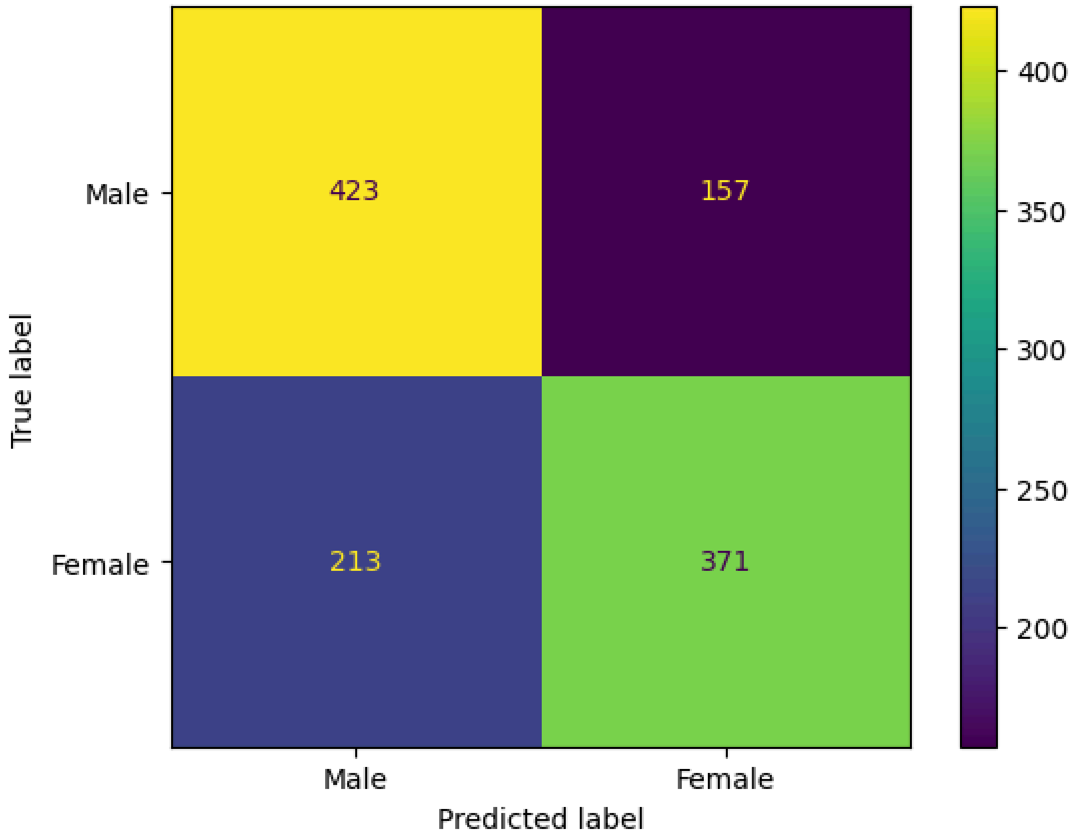
```
(0.6821305841924399,
 0.7026515151515151,
 0.6352739726027398,
 0.6672661870503597)
```

In [34]:

```
confusion_matrix = metrics.confusion_matrix(actual, predicted)
```

In [35]:

```
cm_display = metrics.ConfusionMatrixDisplay(confusion_matrix = confusion_mat
cm_display.plot()
plt.show()
```



In [36]:

```
fname = 'lbp_svm_model.sav'
pickle.dump(model_lbp, open(fname, 'wb'))
```

In [37]:

```
loaded_model = pickle.load(open(fname, 'rb'))
```

In [38]:

```
# Asagidaki img_path degiskenine istenen goruntulerin pathi verilir ve lbp i

img_path = './test_images/064943.jpg.jpg'
img = cv2.imread(img_path, 0)
actual = int(os.path.basename(img_path).startswith('1'))

pred = lbp_predict(loaded_model, img)

if actual == pred:
    print('Gender Detected!')
```

```
Gender Detected!
```

Scale Invariant Feature Transform

In [39]:

```
sift = cv2.SIFT_create()
```

In [40]:

```
def descriptor_extractor(image):
    keypoints, descriptors = sift.detectAndCompute(image, None)
    return keypoints, descriptors
```

In [41]:

```
def preprocessing(img, r_shape):
    img = cv2.resize(img, r_shape, interpolation=cv2.INTER_AREA)
    return img
```

In [42]:

```
def sift_pattern_extractor(desc: cv2.HOGDescriptor, images, gender, num_desc
    data = []
    labels = []

    for img in tqdm(images):
        img_resized = preprocessing(img, r_shape)

        keypoints, descriptors = descriptor_extractor(img_resized)

        if(len(descriptors) < num_descriptors):
            continue

        random_indices = random.sample(range(len(descriptors)), num_descript
        random_descriptors = [descriptors[i] for i in random_indices]

        data.append(random_descriptors)
        labels.append(gender)

    return data, labels
```

In [43]:

```
def sift_detector(model, target_images, gender, ext=ext, r_shape=(128, 128))
    actual, predicted = [], []
    for img in tqdm(target_images, desc='SVM Inference'):
        img_resized = cv2.resize(img, r_shape)

        hist = hog.compute(img_resized)
        hist = hist.flatten()

        pred = model.predict(hist.reshape(1, -1))[0]
        actual.append(gender)
        predicted.append(pred)

    return actual, predicted
```

In [44]:

```
#data_sift_male, labels_sift_male = sift_pattern_extractor(sift, train_male_
#data_sift_female, labels_sift_female = sift_pattern_extractor(sift, train_f
```

In [45]:

```
#data = np.vstack((data_sift_male, data_sift_female))
#labels = np.hstack((labels_sift_male, labels_sift_female))
```

In [46]:

```
## Bag of Words will be implemented (feedback)
```