


```

  Could not connect to the reCAPTCHA service. Please check your internet connection and reload to get a reCAPTCHA challenge.
  pattern_hw_03.ipynb
  PRO File Edit View Insert Runtime Tools Help All changes saved
  Files
  sample_data facedata.mat
  + Code + Text
  [1] w: [[1.19202922e-01 8.80797076e-01 1.81545008e-09]
  (7.31058579e-01 2.68941421e-01 1.69570706e-16]
  [2.68941421e-01 7.31058579e-01 1.01529059e-11]
  [9.99932399e-01 1.67014218e-05 2.0319874e-42]
  [9.99932399e-01 1.67014218e-05 2.0319874e-42]
  [9.99766050e-01 1.23394576e-04 3.30529272e-37]
  [2.1952283e-16 1.38879453e-11 1.00000000e+00]
  [2.1952283e-16 1.38879453e-11 1.00000000e+00]
  [1.30344593e-02 1.08758623e-168 1.00000000e+00]
  m: [0.45757242e-02 0.20959425e-03 0.33333333]
  mu: [[ 5.7899269 5.81187265]
  [ 1.67718211 2.51522165]
  [-3.9998589 -4.6666501]
  covar_mtx: [array([[4.53619412, 0,
  [0, 4.28700611], array([0.51645579, 0,
  [0, 0.13152618], array([4.66666668, 0,
  [0, 2.88888991]])]
  [1 0 1 0 0 0 2 2]
  w: [[3.16932821e-003 9.98624702e-001 5.96935641e-006]
  (6.3801383e-003 1.94221645e-001 6.42250485e-006]
  [5.77503537e-003 9.94221645e-001 1.30002282e-006]
  [1.00000000e+000 9.14501760e-073 4.53098372e-019]
  [1.00000000e+000 3.18241707e-032 5.49960655e-014]
  [1.00000000e+000 1.86592722e-033 9.43022126e-019]
  [4.73612484e-008 1.9798704e-052 9.9999953e-001]
  [3.0852694e-008 1.35874716e-067 9.9999996e-001]
  [5.3959443e-016 1.08758623e-168 1.00000000e+000]
  m: [[ 6.27374212 6.2726215]
  [-3.9998589 2.14766812]
  [ 1.72091544 2.14766812]
  [-3.9998589 -4.6666501]
  covar_mtx: [array([[1.94472736, 0,
  [0, 2.93847196], array([0.49649261, 0,
  [0, 0.12588415], array([4.66673088, 0,
  [0, 2.88880236]])]
  [1 0 1 0 0 0 2 2]
  w: [[9.8289743e-005 9.99896667e-001 5.04302423e-006]
  [2.45954574e-001 7.54032959e-001 1.23094211e-006]
  [3.1801383e-004 9.98624702e-001 9.43022126e-006]
  [5.77503537e-003 9.94221645e-001 1.30002282e-006]
  [1.00000000e+000 9.14501760e-073 4.53098372e-019]
  [1.00000000e+000 3.18241707e-032 5.49960655e-014]
  [1.00000000e+000 1.86592722e-033 9.43022126e-019]
  [4.73612484e-008 1.9798704e-052 9.9999953e-001]
  [3.0852694e-008 1.35874716e-067 9.9999996e-001]
  [5.3959443e-016 1.08758623e-168 1.00000000e+000]
  m: [[ 6.3607999 6.49629468]
  [-1.19307238 2.27385436]
  [-3.9998589 -4.6666501]
  covar_mtx: [array([[1.73961067, 0,
  [0, 1.94472736], array([0.49649261, 0,
  [0, 0.12588415], array([4.66673088, 0,
  [0, 2.88889545]])]
  [1 0 1 0 0 0 2 2]
  w: [[9.8289743e-005 9.99896667e-001 5.04302423e-006]
  [2.45954574e-001 7.54032959e-001 1.23094211e-006]
  [3.1801383e-004 9.98624702e-001 9.43022126e-006]
  [5.77503537e-003 9.94221645e-001 1.30002282e-006]
  [1.00000000e+000 9.14501760e-073 4.53098372e-019]
  [1.00000000e+000 3.18241707e-032 5.49960655e-014]
  [1.00000000e+000 1.86592722e-033 9.43022126e-019]
  [4.73612484e-008 1.9798704e-052 9.9999953e-001]
  [3.0852694e-008 1.35874716e-067 9.9999996e-001]
  [5.3959443e-016 1.08758623e-168 1.00000000e+000]
  m: [[ 6.3607999 0.30595677 0.33333414]
  mui: [[ 6.3607999 0.30595677 0.33333421]
  mu: [[ 6.3607999 6.49629468]
  [-1.19307238 2.27385436]
  [-3.9998589 -4.6666501]
  covar_mtx: [array([[1.73961067, 0,
  [0, 1.94472736], array([0.49649261, 0,
  [0, 0.12588415], array([4.66673088, 0,
  [0, 2.88889545]])]
  [1 1 0 0 0 2 2]
  -36.5
  -37.0
  -37.5
  -38.0
  -38.5
  -39.0
  -39.5
  100 125 150 175 200 225 250 275 300

```

colab.research.google.com/drive/1RTG8vP3Azs3wZRsh4wxYa85v_UVUAMZE#scrollTo=cZfVaztuq3Cw

File Edit View Insert Runtime Tools Help All changes saved

```

T3,T4

[2] n_mixtures = 2
mu = np.array(([3, 3], [-3, -3]))
covar_mtx = np.identity(2)*n_mixtures
n = np.array([1/n_mixtures]*n_mixtures)
log_likelihood_list_2 = []
iteration = 3
for i in range(iteration):
    w_new = e_step(data, n, mu, covar_mtx)
    log_likelihood_list_2.append(log_likelihood(n, mu, covar_mtx))
    print(f'w: {w_new}')
    print(f'm: {mu}')
    print(f'mu: {mu}')
    print(f'covar_mtx: {covar_mtx}')
    x = np.arange(1, iteration)
    y = np.array(log_likelihood_list_2)
    plt.plot(x, y)
    plt.show()

w: [[9.9999998e-01 1.52299795e-08]
 [1.0000000e+00 2.11952283e-16]
 [1.0000000e+00 3.0000000e-11]
 [1.0000000e+00 5.21092564e-12]
 [1.0000000e+00 5.38018616e-32]
 [1.0000000e+00 3.30570063e-37]
 [2.0e+00 2.2223e-16 1.0000000e+00]
 [2.0e+00 2.11952283e-16 1.0000000e+00]
 [3.0e+00 3.0000000e-37 1.0000000e+00]]
mu: [[6.6666664 0.33333334]
 [4.0000001 4.6666667]
 [-3.9999997 -4.6666665]]
covar_mtx: [array([[6.91666665, 0,
                    5.8888889], [0, 1.21413834]]),
           array([[4.66666677, 0,
                    5.8888889], [0, 1.20725262]]),
           array([[2.59403324e-07],
                  [9.99997924e-01 2.59403324e-07]])
[9.99997924e-01 2.59403324e-07]
[9.99997924e-01 2.40783341e-05]
[1.0000000e+00 9.9999999e-19]
[1.0000000e+00 4.1043154e-14]
[1.0000000e+00 2.98366370e-16]
[2.41448223e-04 9.9798552e-01]
[1.0000000e+00 5.22429310e-09]
[5.22429310e-09 9.3999995e-01]]
mu: [[6.6666643 0.3333564]
 [4.0000001 4.66620178]
 [-3.9999997 -4.66620178]]
covar_mtx: [array([[6.91544755, 0,
                    5.89275124], [0, 9.81051811]]),
           array([[4.66806942, 0,
                    5.89275124], [0, 9.81051811]]),
           array([[2.59403324e-01 1.20725262e-07],
                  [9.99997924e-01 2.59403324e-07]])
[9.99997924e-01 2.59403324e-07]
[9.99997924e-01 2.40783341e-05]
[1.0000000e+00 9.9999999e-19]
[1.0000000e+00 4.1043154e-14]
[1.0000000e+00 2.98366370e-16]
[2.41448223e-04 9.9798552e-01]
[1.0000000e+00 5.22429310e-09]
[5.22429310e-09 9.3999995e-01]]
mu: [[6.6666643 0.3333564]
 [4.0000001 4.66620178]
 [-3.9999997 -4.66620178]]
covar_mtx: [array([[6.91544755, 0,
                    5.89275124], [0, 9.81051811]]),
           array([[4.66806942, 0,
                    5.89275124], [0, 9.81051811]]),
           array([[2.59403324e-01 1.21413834e-04],
                  [9.99997858e-01 2.61769575e-04]])
[9.99997858e-01 2.61769575e-04]
[9.9999770e-01 2.42269530e-05]
[1.0000000e+00 9.9999999e-19]
[1.0000000e+00 5.14839047e-14]
[1.0000000e+00 3.04963776e-16]
[2.42726297e-04 9.9797207e-01]
[1.0000000e+00 5.28825254e-09]
[5.28825254e-09 9.3999995e-01]]
mu: [[6.6666645 0.3333547]
 [4.0000001 4.66619903]
 [-3.9999997 -4.66619903]]
covar_mtx: [array([[6.91544672, 0,
                    5.89277411], [0, 2.89104566]]),
           array([[4.66807754, 0,
                    5.89277411], [0, 2.89104566]]),
           array([-4.4529193e-01
                  [-59.8
                     -59.6
                     -59.4
                     -59.2
                     -59.0
                     -58.8
                     -58.6
                     -58.4
                     -58.2
                     -58.0
                     -57.8
                     -57.6
                     -57.4
                     -57.2
                     -57.0
                     -56.8
                     -56.6
                     -56.4
                     -56.2
                     -56.0
                     -55.8
                     -55.6
                     -55.4
                     -55.2
                     -55.0
                     -54.8
                     -54.6
                     -54.4
                     -54.2
                     -54.0
                     -53.8
                     -53.6
                     -53.4
                     -53.2
                     -53.0
                     -52.8
                     -52.6
                     -52.4
                     -52.2
                     -52.0
                     -51.8
                     -51.6
                     -51.4
                     -51.2
                     -51.0
                     -50.8
                     -50.6
                     -50.4
                     -50.2
                     -50.0
                     -49.8
                     -49.6
                     -49.4
                     -49.2
                     -49.0
                     -48.8
                     -48.6
                     -48.4
                     -48.2
                     -48.0
                     -47.8
                     -47.6
                     -47.4
                     -47.2
                     -47.0
                     -46.8
                     -46.6
                     -46.4
                     -46.2
                     -46.0
                     -45.8
                     -45.6
                     -45.4
                     -45.2
                     -45.0
                     -44.8
                     -44.6
                     -44.4
                     -44.2
                     -44.0
                     -43.8
                     -43.6
                     -43.4
                     -43.2
                     -43.0
                     -42.8
                     -42.6
                     -42.4
                     -42.2
                     -42.0
                     -41.8
                     -41.6
                     -41.4
                     -41.2
                     -41.0
                     -40.8
                     -40.6
                     -40.4
                     -40.2
                     -40.0
                     -39.8
                     -39.6
                     -39.4
                     -39.2
                     -39.0
                     -38.8
                     -38.6
                     -38.4
                     -38.2
                     -38.0
                     -37.8
                     -37.6
                     -37.4
                     -37.2
                     -37.0
                     -36.8
                     -36.6
                     -36.4
                     -36.2
                     -36.0
                     -35.8
                     -35.6
                     -35.4
                     -35.2
                     -35.0
                     -34.8
                     -34.6
                     -34.4
                     -34.2
                     -34.0
                     -33.8
                     -33.6
                     -33.4
                     -33.2
                     -33.0
                     -32.8
                     -32.6
                     -32.4
                     -32.2
                     -32.0
                     -31.8
                     -31.6
                     -31.4
                     -31.2
                     -31.0
                     -30.8
                     -30.6
                     -30.4
                     -30.2
                     -30.0
                     -29.8
                     -29.6
                     -29.4
                     -29.2
                     -29.0
                     -28.8
                     -28.6
                     -28.4
                     -28.2
                     -28.0
                     -27.8
                     -27.6
                     -27.4
                     -27.2
                     -27.0
                     -26.8
                     -26.6
                     -26.4
                     -26.2
                     -26.0
                     -25.8
                     -25.6
                     -25.4
                     -25.2
                     -25.0
                     -24.8
                     -24.6
                     -24.4
                     -24.2
                     -24.0
                     -23.8
                     -23.6
                     -23.4
                     -23.2
                     -23.0
                     -22.8
                     -22.6
                     -22.4
                     -22.2
                     -22.0
                     -21.8
                     -21.6
                     -21.4
                     -21.2
                     -21.0
                     -20.8
                     -20.6
                     -20.4
                     -20.2
                     -20.0
                     -19.8
                     -19.6
                     -19.4
                     -19.2
                     -19.0
                     -18.8
                     -18.6
                     -18.4
                     -18.2
                     -18.0
                     -17.8
                     -17.6
                     -17.4
                     -17.2
                     -17.0
                     -16.8
                     -16.6
                     -16.4
                     -16.2
                     -16.0
                     -15.8
                     -15.6
                     -15.4
                     -15.2
                     -15.0
                     -14.8
                     -14.6
                     -14.4
                     -14.2
                     -14.0
                     -13.8
                     -13.6
                     -13.4
                     -13.2
                     -13.0
                     -12.8
                     -12.6
                     -12.4
                     -12.2
                     -12.0
                     -11.8
                     -11.6
                     -11.4
                     -11.2
                     -11.0
                     -10.8
                     -10.6
                     -10.4
                     -10.2
                     -10.0
                     -9.8
                     -9.6
                     -9.4
                     -9.2
                     -9.0
                     -8.8
                     -8.6
                     -8.4
                     -8.2
                     -8.0
                     -7.8
                     -7.6
                     -7.4
                     -7.2
                     -7.0
                     -6.8
                     -6.6
                     -6.4
                     -6.2
                     -6.0
                     -5.8
                     -5.6
                     -5.4
                     -5.2
                     -5.0
                     -4.8
                     -4.6
                     -4.4
                     -4.2
                     -4.0
                     -3.8
                     -3.6
                     -3.4
                     -3.2
                     -3.0
                     -2.8
                     -2.6
                     -2.4
                     -2.2
                     -2.0
                     -1.8
                     -1.6
                     -1.4
                     -1.2
                     -1.0
                     -0.8
                     -0.6
                     -0.4
                     -0.2
                     -0.0
                     0.2
                     0.4
                     0.6
                     0.8
                     1.0
                     1.2
                     1.4
                     1.6
                     1.8
                     2.0
                     2.2
                     2.4
                     2.6
                     2.8
                     3.0
                     3.2
                     3.4
                     3.6
                     3.8
                     4.0
                     4.2
                     4.4
                     4.6
                     4.8
                     5.0
                     5.2
                     5.4
                     5.6
                     5.8
                     6.0
                     6.2
                     6.4
                     6.6
                     6.8
                     7.0
                     7.2
                     7.4
                     7.6
                     7.8
                     8.0
                     8.2
                     8.4
                     8.6
                     8.8
                     9.0
                     9.2
                     9.4
                     9.6
                     9.8
                     10.0
                     10.2
                     10.4
                     10.6
                     10.8
                     11.0
                     11.2
                     11.4
                     11.6
                     11.8
                     12.0
                     12.2
                     12.4
                     12.6
                     12.8
                     13.0
                     13.2
                     13.4
                     13.6
                     13.8
                     14.0
                     14.2
                     14.4
                     14.6
                     14.8
                     15.0
                     15.2
                     15.4
                     15.6
                     15.8
                     16.0
                     16.2
                     16.4
                     16.6
                     16.8
                     17.0
                     17.2
                     17.4
                     17.6
                     17.8
                     18.0
                     18.2
                     18.4
                     18.6
                     18.8
                     19.0
                     19.2
                     19.4
                     19.6
                     19.8
                     20.0
                     20.2
                     20.4
                     20.6
                     20.8
                     21.0
                     21.2
                     21.4
                     21.6
                     21.8
                     22.0
                     22.2
                     22.4
                     22.6
                     22.8
                     23.0
                     23.2
                     23.4
                     23.6
                     23.8
                     24.0
                     24.2
                     24.4
                     24.6
                     24.8
                     25.0
                     25.2
                     25.4
                     25.6
                     25.8
                     26.0
                     26.2
                     26.4
                     26.6
                     26.8
                     27.0
                     27.2
                     27.4
                     27.6
                     27.8
                     28.0
                     28.2
                     28.4
                     28.6
                     28.8
                     29.0
                     29.2
                     29.4
                     29.6
                     29.8
                     30.0
                     30.2
                     30.4
                     30.6
                     30.8
                     31.0
                     31.2
                     31.4
                     31.6
                     31.8
                     32.0
                     32.2
                     32.4
                     32.6
                     32.8
                     33.0
                     33.2
                     33.4
                     33.6
                     33.8
                     34.0
                     34.2
                     34.4
                     34.6
                     34.8
                     35.0
                     35.2
                     35.4
                     35.6
                     35.8
                     36.0
                     36.2
                     36.4
                     36.6
                     36.8
                     37.0
                     37.2
                     37.4
                     37.6
                     37.8
                     38.0
                     38.2
                     38.4
                     38.6
                     38.8
                     39.0
                     39.2
                     39.4
                     39.6
                     39.8
                     40.0
                     40.2
                     40.4
                     40.6
                     40.8
                     41.0
                     41.2
                     41.4
                     41.6
                     41.8
                     42.0
                     42.2
                     42.4
                     42.6
                     42.8
                     43.0
                     43.2
                     43.4
                     43.6
                     43.8
                     44.0
                     44.2
                     44.4
                     44.6
                     44.8
                     45.0
                     45.2
                     45.4
                     45.6
                     45.8
                     46.0
                     46.2
                     46.4
                     46.6
                     46.8
                     47.0
                     47.2
                     47.4
                     47.6
                     47.8
                     48.0
                     48.2
                     48.4
                     48.6
                     48.8
                     49.0
                     49.2
                     49.4
                     49.6
                     49.8
                     50.0
                     50.2
                     50.4
                     50.6
                     50.8
                     51.0
                     51.2
                     51.4
                     51.6
                     51.8
                     52.0
                     52.2
                     52.4
                     52.6
                     52.8
                     53.0
                     53.2
                     53.4
                     53.6
                     53.8
                     54.0
                     54.2
                     54.4
                     54.6
                     54.8
                     55.0
                     55.2
                     55.4
                     55.6
                     55.8
                     56.0
                     56.2
                     56.4
                     56.6
                     56.8
                     57.0
                     57.2
                     57.4
                     57.6
                     57.8
                     58.0
                     58.2
                     58.4
                     58.6
                     58.8
                     59.0
                     59.2
                     59.4
                     59.6
                     59.8
                     60.0
                     60.2
                     60.4
                     60.6
                     60.8
                     61.0
                     61.2
                     61.4
                     61.6
                     61.8
                     62.0
                     62.2
                     62.4
                     62.6
                     62.8
                     63.0
                     63.2
                     63.4
                     63.6
                     63.8
                     64.0
                     64.2
                     64.4
                     64.6
                     64.8
                     65.0
                     65.2
                     65.4
                     65.6
                     65.8
                     66.0
                     66.2
                     66.4
                     66.6
                     66.8
                     67.0
                     67.2
                     67.4
                     67.6
                     67.8
                     68.0
                     68.2
                     68.4
                     68.6
                     68.8
                     69.0
                     69.2
                     69.4
                     69.6
                     69.8
                     70.0
                     70.2
                     70.4
                     70.6
                     70.8
                     71.0
                     71.2
                     71.4
                     71.6
                     71.8
                     72.0
                     72.2
                     72.4
                     72.6
                     72.8
                     73.0
                     73.2
                     73.4
                     73.6
                     73.8
                     74.0
                     74.2
                     74.4
                     74.6
                     74.8
                     75.0
                     75.2
                     75.4
                     75.6
                     75.8
                     76.0
                     76.2
                     76.4
                     76.6
                     76.8
                     77.0
                     77.2
                     77.4
                     77.6
                     77.8
                     78.0
                     78.2
                     78.4
                     78.6
                     78.8
                     79.0
                     79.2
                     79.4
                     79.6
                     79.8
                     80.0
                     80.2
                     80.4
                     80.6
                     80.8
                     81.0
                     81.2
                     81.4
                     81.6
                     81.8
                     82.0
                     82.2
                     82.4
                     82.6
                     82.8
                     83.0
                     83.2
                     83.4
                     83.6
                     83.8
                     84.0
                     84.2
                     84.4
                     84.6
                     84.8
                     85.0
                     85.2
                     85.4
                     85.6
                     85.8
                     86.0
                     86.2
                     86.4
                     86.6
                     86.8
                     87.0
                     87.2
                     87.4
                     87.6
                     87.8
                     88.0
                     88.2
                     88.4
                     88.6
                     88.8
                     89.0
                     89.2
                     89.4
                     89.6
                     89.8
                     90.0
                     90.2
                     90.4
                     90.6
                     90.8
                     91.0
                     91.2
                     91.4
                     91.6
                     91.8
                     92.0
                     92.2
                     92.4
                     92.6
                     92.8
                     93.0
                     93.2
                     93.4
                     93.6
                     93.8
                     94.0
                     94.2
                     94.4
                     94.6
                     94.8
                     95.0
                     95.2
                     95.4
                     95.6
                     95.8
                     96.0
                     96.2
                     96.4
                     96.6
                     96.8
                     97.0
                     97.2
                     97.4
                     97.6
                     97.8
                     98.0
                     98.2
                     98.4
                     98.6
                     98.8
                     99.0
                     99.2
                     99.4
                     99.6
                     99.8
                     100.0
                     100.2
                     100.4
                     100.6
                     100.8
                     101.0
                     101.2
                     101.4
                     101.6
                     101.8
                     102.0
                     102.2
                     102.4
                     102.6
                     102.8
                     103.0
                     103.2
                     103.4
                     103.6
                     103.8
                     104.0
                     104.2
                     104.4
                     104.6
                     104.8
                     105.0
                     105.2
                     105.4
                     105.6
                     105.8
                     106.0
                     106.2
                     106.4
                     106.6
                     106.8
                     107.0
                     107.2
                     107.4
                     107.6
                     107.8
                     108.0
                     108.2
                     108.4
                     108.6
                     108.8
                     109.0
                     109.2
                     109.4
                     109.6
                     109.8
                     110.0
                     110.2
                     110.4
                     110.6
                     110.8
                     111.0
                     111.2
                     111.4
                     111.6
                     111.8
                     112.0
                     112.2
                     112.4
                     112.6
                     112.8
                     113.0
                     113.2
                     113.4
                     113.6
                     113.8
                     114.0
                     114.2
                     114.4
                     114.6
                     114.8
                     115.0
                     115.2
                     115.4
                     115.6
                     115.8
                     116.0
                     116.2
                     116.4
                     116.6
                     116.8
                     117.0
                     117.2
                     117.4
                     117.6
                     117.8
                     118.0
                     118.2
                     118.4
                     118.6
                     118.8
                     119.0
                     119.2
                     119.4
                     119.6
                     119.8
                     120.0
                     120.2
                     120.4
                     120.6
                     120.8
                     121.0
                     121.2
                     121.4
                     121.6
                     121.8
                     122.0
                     122.2
                     122.4
                     122.6
                     122.8
                     123.0
                     123.2
                     123.4
                     123.6
                     123.8
                     124.0
                     124.2
                     124.4
                     124.6
                     124.8
                     125.0
                     125.2
                     125.4
                     125.6
                     125.8
                     126.0
                     126.2
                     126.4
                     126.6
                     126.8
                     127.0
                     127.2
                     127.4
                     127.6
                     127.8
                     128.0
                     128.2
                     128.4
                     128.6
                     128.8
                     129.0
                     129.2
                     129.4
                     129.6
                     129.8
                     130.0
                     130.2
                     130.4
                     130.6
                     130.8
                     131.0
                     131.2
                     131.4
                     131.6
                     131.8
                     132.0
                     132.2
                     132.4
                     132.6
                     132.8
                     133.0
                     133.2
                     133.4
                     133.6
                     133.8
                     134.0
                     134.2
                     134.4
                     134.6
                     134.8
                     135.0
                     135.2
                     135.4
                     135.6
                     135.8
                     136.0
                     136.2
                     136.4
                     136.6
                     136.8
                     137.0
                     137.2
                     137.4
                     137.6
                     137.8
                     138.0
                     138.2
                     138.4
                     138.6
                     138.8
                     139.0
                     139.2
                     139.4
                     139.6
                     139.8
                     140.0
                     140.2
                     140.4
                     140.6
                     140.8
                     141.0
                     141.2
                     141.4
                     141.6
                     141.8
                     142.0
                     142.2
                     142.4
                     142.6
                     142.8
                     143.0
                     143.2
                     143.4
                     143.6
                     143.8
                     144.0
                     144.2
                     144.4
                     144.6
                     144.8
                     145.0
                     145.2
                     145.4
                     145.6
                     145.8
                     146.0
                     146.2
                     146.4
                     146.6
                     146.8
                     147.0
                     147.2
                     147.4
                     147.6
                     147.8
                     148.0
                     148.2
                     148.4
                     148.6
                     148.8
                     149.0
                     149.2
                     149.4
                     149.6
                     149.8
                     150.0
                     150.2
                     150.4
                     150.6
                     150.8
                     151.0
                     151.2
                     151.4
                     151.6
                     151.8
                     152.0
                     152.2
                     152.4
                     152.6
                     152.8
                     153.0
                     153.2
                     153.4
                     153.6
                     153.8
                     154.0
                     154.2
                     154.4
                     154.6
                     154.8
                     155.0
                     155.2
                     155.4
                     155.6
                     155.8
                     156.0
                     156.2
                     156.4
                     156.6
                     156.8
                     157.0
                     157.2
                     157.4
                     157.6
                     157.8
                     158.0
                     158.2
                     158.4
                     158.6
                     158.8
                     159.0
                     159.2
                     159.4
                     159.6
                     159.8
                     160.0
                     160.2
                     160.4
                     160.6
                     160.8
                     161.0
                     161.2
                     161.4
                     161.6
                     161.8
                     162.0
                     162.2
                     162.4
                     162.6
                     162.8
                     163.0
                     163.2
                     163.4
                     163.6
                     163.8
                     164.0
                     164.2
                     164.4
                     164.6
                     164.8
                     165.0
                     165.2
                     165.4
                     165.6
                     165.8
                     166.0
                     166.2
                     166.4
                     166.6
                     166.8
                     167.0
                     167.2
                     167.4
                     167.6
                     167.8
                     168.0
                     168.2
                     168.4
                     168.6
                     168.8
                     169.0
                     169.2
                     169.4
                     169.6
                     169.8
                     170.0
                     170.2
                     170.4
                     170.6
                     170.8
                     171.0
                     171.2
                     171.4
                     171.6
                     171.8
                     172.0
                     172.2
                     172.4
                     172.6
                     172.8
                     173.0
                     173.2
                     173.4
                     173.6
                     173.8
                     174.0
                     174.2
                     174.4
                     174.6
                     174.8
                     175.0
                     175.2
                     175.4
                     175.6
                     175.8
                     176.0
                     176.2
                     176.4
                     176.6
                     176.8
                     177.0
                     177.2
                     177.4
                     177.6
                     177.8
                     178.0
                     178.2
                     178.4
                     178.6
                     178.8
                     179.0
                     179.2
                     179.4
                     179.6
                     179.8
                     180.0
                     180.2
                     180.4
                     180.6
                     180.8
                     181.0
                     181.2
                     181.4
                     181.6
                     181.8
                     182.0
                     182.2
                     182.4
                     182.6
                     182.8
                     183.0
                     183.2
                     183.4
                     183.6
                     183.8
                     184.0
                     184.2
                     184.4
                     184.6
                     184.8
                     185.0
                     185.2
                     185.4
                     185.6
                     185.8
                     186.0
                     186.2
                     186.4
                     186.6
                     186.8
                     187.0
                     187.2
                     187.4
                     187.6
                     187.8
                     188.0
                     188.2
                     188.4
                     188.6
                     188.8
                     189.0
                     189.2
                     189.4
                     189.6
                     189.8
                     190.0
                     190.2
                     190.4
                     190.6
                     190.8
                     191.0
                     191.2
                     191.4
                     191.6
                     191.8
                     192.0
                     192.2
                     192.4
                     192.6
                     192.8
                     193.0
                     193.2
                     193.4
                     193.6
                     193.8
                     194
```

The 3-estimator GMM is better than 2-estimator GMM in all iterations in terms of log-likelihood.

Could not connect to the reCAPTCHA service. Please check your internet connection and reload to get a reCAPTCHA challenge.

`pattern_hw_03.ipynb`

File Edit View Insert Runtime Tools Help All changes saved

+ Code + Text

[2]: [2, 42792697e-04 9.99757207e-01] [1] [5.2884254e-09 9.39999995e-01] [5.2884254e-09 9.39999995e-01] m1: [0.66664945] m1: [[4.4996108, 4.66613993] [-3.9999206, -4.66613993] covar_max1: [array([[4.915445372, 0., 0., 0., 5.8927741], [0., 2.89104566]])]

[3]: plt.plot(np.arange(1,iteration+1), log_likelihood_list, label='3 gaussians') plt.plot(np.arange(1,iteration+1), log_likelihood_list_2, label='2 gaussians') plt.legend() plt.show()

[] # !wget https://github.com/ekapolc/pattern_2022/blob/main/HW/HW03/facedata_mat.zip

[4]: import scipy.io from skimage import img_as_float x = scipy.io.loadmat('/content/facedata.mat') xf = x for i in range(x['facedata'].shape[0]):

pattern_hw_0...ipynb pattern_hw_03.ipynb facedata_mat (4).zip facedata_mat (3).zip facedata_mat (2).zip Show All

colab.research.google.com/drive/1RTG8vP3Azs3wZRsh4wxYa85v_UVUAMZE#scrollTo=cZfVaztuq3Cw

File Edit View Insert Runtime Tools Help All changes saved

T5

```
[5] def euclidean_dist(a, b):
    diff = np.sqrt(np.sum(np.power(a.reshape(-1) - b.reshape(-1), 2)))
    return diff
print(euclidean_dist(xf[0, 0], xf[0, 1]))
print(euclidean_dist(xf[0, 0], xf[1, 0]))
```

10.037616294165492
8.17329509737281

T6

```
[6] def get_similarity_mtx(T, D):
    m = len(T)
    n = len(D)
    A = np.zeros((m, n))
    for i in range(m):
        for j in range(n):
            if i == j:
                A[i, j] = np.sqrt(np.sum(np.power(T[i].reshape(-1) - D[j].reshape(-1), 2)))
            plt.imshow(A, cmap="gray")
            plt.show()
    return A
```

T7

```
[7] def get_T_D(xf):
    T = []
    D = []
    for i in range(40):
        for j in range(10):
            if j <= 2:
                T.append(xf[i, j])
            else:
                D.append(xf[i, j])
    return T, D
```

T8

```
[8] T, D = get_T_D(xf)
A = get_similarity_mtx(T, D)
```

[131] print('In my opinion, the black square in [5:10, 5:10] represents the similarity between the images which come from the same people.')

In my opinion, the black square in [5:10, 5:10] represents the similarity between the images which come from the same people.

T9

```
[132] def get_tp_fa(A, t):
    test_num = A.shape[1]
    train_num = A.shape[0]
    tp = 0
    tn = 0
    fp = 0
    fn = 0
    for test_idx in range(test_num):
        people_face_dis_list = (A.max())*(train_num//3)
        train_idx = int(np.random.choice(range(train_num), 1))
        people_face_dis_list[train_idx//3] = min(people_face_dis_list[train_idx//3], A[train_idx, test_idx])
        for idx, dis in enumerate(people_face_dis_list):
            if idx < t and test_idx//3 == idx:
                tp += 1
            elif dis >= t and test_idx//3 == idx:
                fn += 1
            elif dis < t and test_idx//3 != idx:
                fp += 1
            else:
                tn += 1
    tp_rate = tp/(tp + fn)
    fa_rate = fp/(fp + tn)
    return tp_rate, fa_rate
```

[133] tp_rate, fa_rate = get_tp_fa(A, 10)
print('At t=10, tp_rate: ', tp_rate)
print('At t=10, fa_rate: ', fa_rate)

At t=10, tp_rate: 0.9964285714285714
At t=10, fa_rate: 0.4564102564102564

colab.research.google.com/drive/1RTG8vP3Azs3wZRsh4wxYa85v_UVUAMZE#scrollTo=cZfVaztuq3Cw

pattern_hw_03.ipynb

```

At t=10, tp_rate: 0.9964285714285714
At t=10, fa_rate: 0.4564102564102564

T9

[133] def plot_roc(A, num=1000):
    min_thres = A.min()
    max_thres = A.max()
    thresholds = np.linspace(min_thres, max_thres, num=num)
    tp_rate_list = []
    fa_rate_list = []
    all_rate = []
    for t in thresholds:
        tp, fa = get_tp_fa(A, t)
        tp_rate_list.append(tp_rate)
        fa_rate_list.append(fa_rate)
        all_rate.append((t, tp_rate, fa_rate))
    tp_rate_list = np.array(tp_rate_list), np.array(fa_rate_list)
    plt.title('ROC')
    plt.plot(tp_rate_list, fa_rate_list)
    plt.xlabel('True Positive Rate')
    plt.ylabel('False Alarm Rate')
    plt.legend()
    return all_rate
all_rate = plot_roc(A)
print(f'The lowest and the highest value of A should be the minimum and the maximum thresholds, respectively.')

```

The lowest and the highest value of A should be the minimum and the maximum thresholds, respectively.

T10

```

[147] for t, tp_rate, fa_rate in all_rate:
    if abs(tp_rate - 1 + fa_rate) <= 4e-3:
        print(f'ERR: ({t})')

```

Disk 183.90 GB available

pattern_hw_0...ipynb pattern_hw_03.ipynb facedata_mat (4).zip facedata_mat (3).zip facedata_mat (2).zip

Show All

colab.research.google.com/drive/1RTG8vP3Azs3wZRsh4wxYa85v_UVUAMZE#scrollTo=cZfVaztuq3Cw

pattern_hw_03.ipynb

```

At t=10, tp_rate: 0.9964285714285714
At t=10, fa_rate: 0.4564102564102564

T9

[133] def plot_roc(A, num=1000):
    min_thres = A.min()
    max_thres = A.max()
    thresholds = np.linspace(min_thres, max_thres, num=num)
    tp_rate_list = []
    fa_rate_list = []
    all_rate = []
    for t in thresholds:
        tp, fa = get_tp_fa(A, t)
        tp_rate_list.append(tp_rate)
        fa_rate_list.append(fa_rate)
        all_rate.append((t, tp_rate, fa_rate))
    tp_rate_list = np.array(tp_rate_list), np.array(fa_rate_list)
    plt.title('ROC')
    plt.plot(tp_rate_list, fa_rate_list)
    plt.xlabel('True Positive Rate')
    plt.ylabel('False Alarm Rate')
    plt.legend()
    return all_rate
all_rate = plot_roc(A)
print(f'The lowest and the highest value of A should be the minimum and the maximum thresholds, respectively.')

```

The lowest and the highest value of A should be the minimum and the maximum thresholds, respectively.

T10

```

[147] for t, tp_rate, fa_rate in all_rate:
    if abs(tp_rate - 1 + fa_rate) <= 4e-3:
        print(f'ERR: ({t})')
        print(f'DP rate: ({tp_rate})')
        print(f'FA rate: ({fa_rate})')
        if abs(fa_rate - 0.0016) <= 5e-5:
            print(f'recall rate: ({tp_rate}) at False Alarm rate: 10%')

recall rate: 0.5428571428571428 at False Alarm rate: 10%
ERR: 8.084041408785595
tp rate: 0.9071428571428571
fa rate: 0.08891941391941392

```

T11

```

[149] T_np = np.array(T)
D_np = np.array(D)
average_face = np.average(T_np, axis=0)
plt.imshow(average_face, cmap='gray')
plt.show()

```

T12

```

[149] X_tmp = np.concatenate((T_np, D_np), axis=0)
Y = Y.T
mean = np.mean(X_tmp, axis=0)
X_norm = X_tmp - mean
X_norm = X_norm / np.linalg.norm(X_norm)

```

Disk 183.90 GB available

pattern_hw_0...ipynb pattern_hw_03.ipynb facedata_mat (4).zip facedata_mat (3).zip facedata_mat (2).zip

Show All

colab.research.google.com/drive/1RTG8vP3Azs3wZRsh4wxYa85v_UVUAMZE#scrollTo=cZfVaztuq3Cw

File Edit View Insert Runtime Tools Help All changes saved

```

T12

[149] X_tmp = np.concatenate((T_np, D_np), axis=0)
      X = (X_tmp - average_face).reshape((len(X_tmp), 56*46)).T
      cov_mtx = X.dot(X.T)
      print(f'The dimension of covariance matrix is {cov_mtx.shape}')
      print(f'The rank of covariance matrix is {np.linalg.matrix_rank(cov_mtx)}')
The dimension of covariance matrix is (2576, 2576)
The rank of covariance matrix is 399

T13

[150] gram = X.T.dot(X)
      print(f'The size of Gram matrix is {gram.shape}')
      print(f'The rank of Gram matrix is {np.linalg.matrix_rank(gram)}')
      print(f'We expect to get {len(X_tmp)-1} non-zero values')
The size of Gram matrix is (400, 400)
The rank of Gram matrix is 399
We expect to get 399 non-zero values

T14

[161] def is_symmetric(A):
      is_symmetric = True
      for i in range(A.shape[0]):
          if not is_symmetric:
              break
          for j in range(A.shape[1]):
              if i == j:
                  continue
              elif A[i, j] != A[j, i]:
                  is_symmetric = False
                  break
      return True
is_sym = is_symmetric(gram)
print(f'Gram is a symmetric matrix: {is_sym}')
explain = ...
X-> nnz matrix
X.T-> nnz matrix
gram[i, j] is computed by X.T[i, :].dot(X[:, j])
and gram[i, i] is computed by X.T[i, :].dot(X[i, :])
we also know that a.dot(b) equals b.dot(a)
In addition, X.T[i, :] = X[:, i] and X[i, :] = X.T[:, i].
As a result, gram is a symmetric matrix.

[162] print(explain)

```

Disk 183.90 GB available

Show All

pattern_hw_0.ipynb | pattern_hw_03.ipynb | facedata_mat (4).zip | facedata_mat (3).zip | facedata_mat (2).zip

File Edit View Insert Runtime Tools Help All changes saved

```

T13

[150] gram = X.T.dot(X)
      print(f'The size of Gram matrix is {gram.shape}')
      print(f'The rank of Gram matrix is {np.linalg.matrix_rank(gram)}')
      print(f'We expect to get {len(X_tmp)-1} non-zero values')
The size of Gram matrix is (400, 400)
The rank of Gram matrix is 399
We expect to get 399 non-zero values

T14

[161] def is_symmetric(A):
      is_symmetric = True
      for i in range(A.shape[0]):
          if not is_symmetric:
              break
          for j in range(A.shape[1]):
              if i == j:
                  continue
              elif A[i, j] != A[j, i]:
                  is_symmetric = False
                  break
      return True
is_sym = is_symmetric(gram)
print(f'Gram is a symmetric matrix: {is_sym}')
explain = ...
X-> nnz matrix
X.T-> nnz matrix
gram[i, j] is computed by X.T[i, :].dot(X[:, j])
and gram[i, i] is computed by X.T[i, :].dot(X[i, :])
we also know that a.dot(b) equals b.dot(a)
In addition, X.T[i, :] = X[:, i] and X[i, :] = X.T[:, i].
As a result, gram is a symmetric matrix.

[162] print(explain)

```

Disk 183.90 GB available

Show All

pattern_hw_0.ipynb | pattern_hw_03.ipynb | facedata_mat (4).zip | facedata_mat (3).zip | facedata_mat (2).zip

colab.research.google.com/drive/1RTG8vP3Azs3wZRsh4wxYaB5v_UVUAMZE#scrollTo=cZfVaztuq3Cw

pattern_hw_03.ipynb

```

T15

[156] X_tmp = np.concatenate((T_np, D_np), axis=0)
X = (X_tmp - aveFace).reshape((len(X_tmp), 56*46))
gram = X.T.dot(X)
eigen_val, eigen_vec = np.linalg.eig(gram)
eigen_val = eigen_val[::-1]
eigen_vec = eigen_vec[:, ::-1]
non_zero_eigen = len([a for a in eigen_val if a >= 1e-1])
print('There are {} non zero eigen values'.format(non_zero_eigen))

There are 399 of non zero eigen values

T16

[157] all_var = np.sum(eigen_val)
proportion_var = all_var*.95
var_sum = 0
for idx, eigen_value in enumerate(eigen_val):
    var_sum += eigen_value
    if var_sum > proportion_var:
        print('We use {} eigens value to keep 95% of the original variance.')
        break
plt.plot(np.arange(len(eigen_val)), np.array(eigen_val))
plt.show()

We use 136 eigens value to keep 95% of the original variance.

```

T17, T18

```

Disk 183.90 GB available [117] v = X.dot(eigen_vec)

pattern_hw_0....ipynb pattern_hw_03.ipynb facedata_mat (4).zip facedata_mat (3).zip facedata_mat (2).zip Show All

```

colab.research.google.com/drive/1RTG8vP3Azs3wZRsh4wxYaB5v_UVUAMZE#scrollTo=cZfVaztuq3Cw

pattern_hw_03.ipynb

```

T17, T18

[117] v = X.dot(eigen_vec)
v = v.reshape()
new_v = []
for i in range(v.shape[1]):
    v_size = np.linalg.norm(v[:, i], axis=0)
    new_v.append(v[:, i]/v_size)
new_v = np.array(new_v)
for i in range(10):
    plt.imshow(new_v[i].reshape((56, 46)), cmap="gray")
    plt.show()

(256, 400)

```

Disk 183.90 GB available

```

pattern_hw_0....ipynb pattern_hw_03.ipynb facedata_mat (4).zip facedata_mat (3).zip facedata_mat (2).zip Show All

```

colab.research.google.com/drive/1RTG8vP3Azs3wZRsh4wxYa85v_UVUAMZE#scrollTo=cZfVaztuq3Cw

pattern_hw_03.ipynb

```

[158] explain = """
I think in the first eigen face, it captures the shirt of the person as the color of the shirt is brightest among other pixels.
Regarding the second eigen face, it reflects the forehead of a person.
After observing the original images, I think it is quite reasonable that why these two eigen images are the ones that have the highest variances.
"""

print(explain)

I think in the first eigen face, it captures the shirt of the person as the color of the shirt is brightest among other pixels.
Regarding the second eigen face, it reflects the forehead of a person.
After observing the original images, I think it is quite reasonable that why these two eigen images are the ones that have the highest variances.

T19

[121] k = 10
def get_proj_A(new_v, X, k):
    print(new_v.shape)
    print(X.shape)
    p = new_v[:, 1].dot(X)
    print(p.shape)
    # print(p)
    proj_T = [p[i, e] for e in range(len(T_np))]
    proj_D = [p[i, e*len(T_np)] for e in range(len(D_np))]
    proj_A = get_similaritity_mtx(proj_T, proj_D)
    return proj_A
    proj_A = get_proj_A(new_v, X, k)

(400, 2576)
(2576, 400)


```

Disk 183.90 GB available

[26] all_rate = plot_roc(proj_A)

pattern_hw_0...ipynb pattern_hw_03.ipynb facedata_mat (4).zip facedata_mat (3).zip facedata_mat (2).zip

colab.research.google.com/drive/1RTG8vP3Azs3wZRsh4wxYa85v_UVUAMZE#scrollTo=cZfVaztuq3Cw

pattern_hw_03.ipynb

```

[26] all_rate = plot_roc(proj_A)

ROC

[27] for t, tp_rate, fa_rate in all_rate:
    if abs(tp_rate - 1 + fa_rate) <= 1e-3:
        print(f'ERR: ({t})')
        print(f'tp rate: ({tp_rate})')
        print(f'fa rate: ({fa_rate})')
    elif abs(fa_rate - 0.0016) <= 1e-6:
        print(f'recall rate: ({tp_rate}) at False Alarm rate: 10%')

recall rate: 0.49642857142857144 at False Alarm rate: 10%
```

[28] def get_ERR(all_rate, thres = 5e-3):
 found = False
 for t, tp_rate, fa_rate in all_rate:
 if abs(tp_rate - 1 + fa_rate) <= thres:
 print(f'ERR: ({t})')
 print(f'tp rate: ({tp_rate})')
 print(f'fa rate: ({fa_rate})')
 found = True
 return fa_rate
 if not found:
 thres *= 5
 for t, tp_rate, fa_rate in all_rate:
 if abs(tp_rate - 1 + fa_rate) <= thres:
 print(f'ERR: ({t})')
 print(f'tp rate: ({tp_rate})')
 print(f'fa rate: ({fa_rate})')
 found = True
 return fa_rate
 return None

Disk 183.90 GB available

pattern_hw_0...ipynb pattern_hw_03.ipynb facedata_mat (4).zip facedata_mat (3).zip facedata_mat (2).zip

Could not connect to the reCAPTCHA service. Please check your internet connection and reload to get a reCAPTCHA challenge.

pattern_hw_03.ipynb

```

T20
[31] k_list = [5, 6, 7, 8, 9, 10, 11, 12, 13, 14]
eer_list = []
for k in k_list:
    proj_A = get_proj_A(new_v, X, k)
    all_rate = plot_proj(proj_A)
    eer_list.append((k, get_EER(all_rate)))

ROC
EER: 5.224668744932525
tp rate: 0.9178571428571428
fa rate: 0.07756410254410257
ROC
EER: 5.554114467425525
tp rate: 0.9142857142857143
fa rate: 0.08571428571428572
ROC
EER: 5.554114467425525
tp rate: 0.9142857142857143
fa rate: 0.08571428571428572

```

Disk 183.90 GB available

Show All

pattern_hw_0....ipynb **pattern_hw_03.ipynb** **facedata_mat (4).zip** **facedata_mat (3).zip** **facedata_mat (2).zip**

Could not connect to the reCAPTCHA service. Please check your internet connection and reload to get a reCAPTCHA challenge.

pattern_hw_03.ipynb

```

T20
[31] k_list = [5, 6, 7, 8, 9, 10, 11, 12, 13, 14]
eer_list = []
for k in k_list:
    proj_A = get_proj_A(new_v, X, k)
    all_rate = plot_proj(proj_A)
    eer_list.append((k, get_EER(all_rate)))

ROC
EER: 5.224668744932525
tp rate: 0.9178571428571428
fa rate: 0.07756410254410257
ROC
EER: 5.554114467425525
tp rate: 0.9142857142857143
fa rate: 0.08571428571428572
ROC
EER: 5.554114467425525
tp rate: 0.9142857142857143
fa rate: 0.08571428571428572

```

Disk 183.90 GB available

Show All

pattern_hw_0....ipynb **pattern_hw_03.ipynb** **facedata_mat (4).zip** **facedata_mat (3).zip** **facedata_mat (2).zip**

colab.research.google.com/drive/1RTG8vP3Azs3wZRsh4wxYaB5v_UVUAMZE#scrollTo=cZfVaztuq3Cw

pattern_hw_03.ipynb

```

File Edit View Insert Runtime Tools Help All changes saved
+ Code + Text
T21
[33] print('The rank must be (min(40-1, 400-40))')
The rank must be 39

T22
[164] proj_lPCA = new_v[:,39,:].dot(X)
global_mean = np.mean(proj_lPCA, axis=1)
C = np.cov(X.T)
class_mean = np.zeros((40, 10, 39))
proj_lT = np.array([proj_lPCA[i, e] for e in range(len(T_np))])
proj_lD = np.array([proj_lPCA[i, e:len(T_np)] for e in range(len(D_np))])
for i in range(len(proj_lT)):
    class_mean[i, :, :] = proj_lT[i]
    class_mean[i, :, :] = proj_lT[i]
    for e in range(len(T_np)):
        class_mean[i, :, e] = proj_lD[i]
        within_class_mean = np.mean(class_mean, axis=1)
        S_W = np.zeros((39, 39))
        S_W += np.dot(class_mean, class_mean)
        for c in range(40):
            diff = (within_class_mean[c] - global_mean).reshape((39, 1))
            S_B += diff.dot(diff.T)
            for i in range(39):
                diff = (proj_lT[i*39+e] - within_class_mean[e]).reshape((39, 1))
                S_W += diff.dot(diff.T)
                for j in range(39):
                    diff = (proj_lT[i*39+j] - within_class_mean[j]).reshape((39, 1))
                    S_W += diff.dot(diff.T)
eigen_val_LDA, eigen_vec_LDA = np.linalg.eigh(np.matmul(np.linalg.inv(S_W), S_B))
non_zero = len([(e for e in eigen_val_LDA if e >= 1e-10)])
S_W_inv_S_B_sym = np.linalg.inv(np.linalg.inv(S_W) * S_B)
print(f'There are {non_zero} non-zero values in eigen values')
eigen_val_LDA = eigen_val_LDA[:, :1]
eigen_vec_LDA = eigen_vec_LDA[:, :, :1]
We can still use numpy.linalg.eigh as the S_W inverse x S_B is symmetric: True
There are 22 non-zero values in eigen values

```

Disk 183.90 GB available

Show All

colab.research.google.com/drive/1RTG8vP3Azs3wZRsh4wxYaB5v_UVUAMZE#scrollTo=cZfVaztuq3Cw

pattern_hw_03.ipynb

```

File Edit View Insert Runtime Tools Help All changes saved
+ Code + Text
T23
[165] explain = ***
It is completely different from PCA projection since the eigen face of the LDA belongs to some people,
while the PCA's eigenfaces look like the average of people faces.
** print(explain)

It is completely different from PCA projection since the eigen face of the LDA belongs to some people,
while the PCA's eigenfaces look like the average of people faces.

v_LDA = eigen_vec_LDA.dot(new_v[:, 1])
for i in range(10):
    plt.imshow(v_LDA[i].reshape((56, 46)), cmap="gray")
    plt.show()

```

Disk 183.90 GB available

Show All

Could not connect to the reCAPTCHA service. Please check your internet connection and reload to get a reCAPTCHA challenge.

pattern_hw_03.ipynb

```

[124] proj_A_LDA = get_proj_A(v_LDA, X, 39)
all_rate = plot_roc(proj_A_LDA)
get_EER(all_rate, thresh = 5e-3)

(39, 2576)
(2576, 400)
0
20
40
60
80
100
0 50 100 150 200 250
ROC

The Positive Rate
0.8
0.6
0.4
0.2
0.0
0.0 0.2 0.4 0.6 0.8 1.0

EER: 6.653143453908565
tp rate: 0.07454212454212454
fa rate: 0.07454212454212454

for t, tp_rate, fa_rate in all_rate:
    if abs(fa_rate - 0.001) <= 8e-6:
        print(f'recall rate: {tp_rate} at False Alarm rate: 10%')

recall rate: 0.5897142857142857 at False Alarm rate: 10%

```

Disk 183.90 GB available

pattern_hw_0....ipynb **pattern_hw_03.ipynb** **facedata_mat (4).zip** **facedata_mat (3).zip** **facedata_mat (2).zip**

Could not connect to the reCAPTCHA service. Please check your internet connection and reload to get a reCAPTCHA challenge.

pattern_hw_03.ipynb

```

T25

A = get_similarity_mtx(7, D)
A_new_v = get_proj_A(new_v, X, k=10)
A_LDA = get_proj_A(v_LDA, X, 39)
num = 1000
min_thres = min(A.min(), A_PCA.min(), A_LDA.min())
max_thres = max(A.max(), A_PCA.max(), A_LDA.max())
thres = np.linspace(min_thres, max_thres, num=num)
tp_rate_list = []
fa_rate_list = []
tp_rate_list_PCA = []
fa_rate_list_PCA = []
tp_rate_list_LDA = []
fa_rate_list_LDA = []
for t in thres:
    tp_rate, fa_rate = get_tp_fa(A, t)
    tp_rate_list.append(tp_rate)
    fa_rate_list.append(fa_rate)

    tp_rate_PCA, fa_rate_PCA = get_tp_fa(A_PCA, t)
    tp_rate_list_PCA.append(tp_rate_PCA)
    fa_rate_list_PCA.append(fa_rate_PCA)

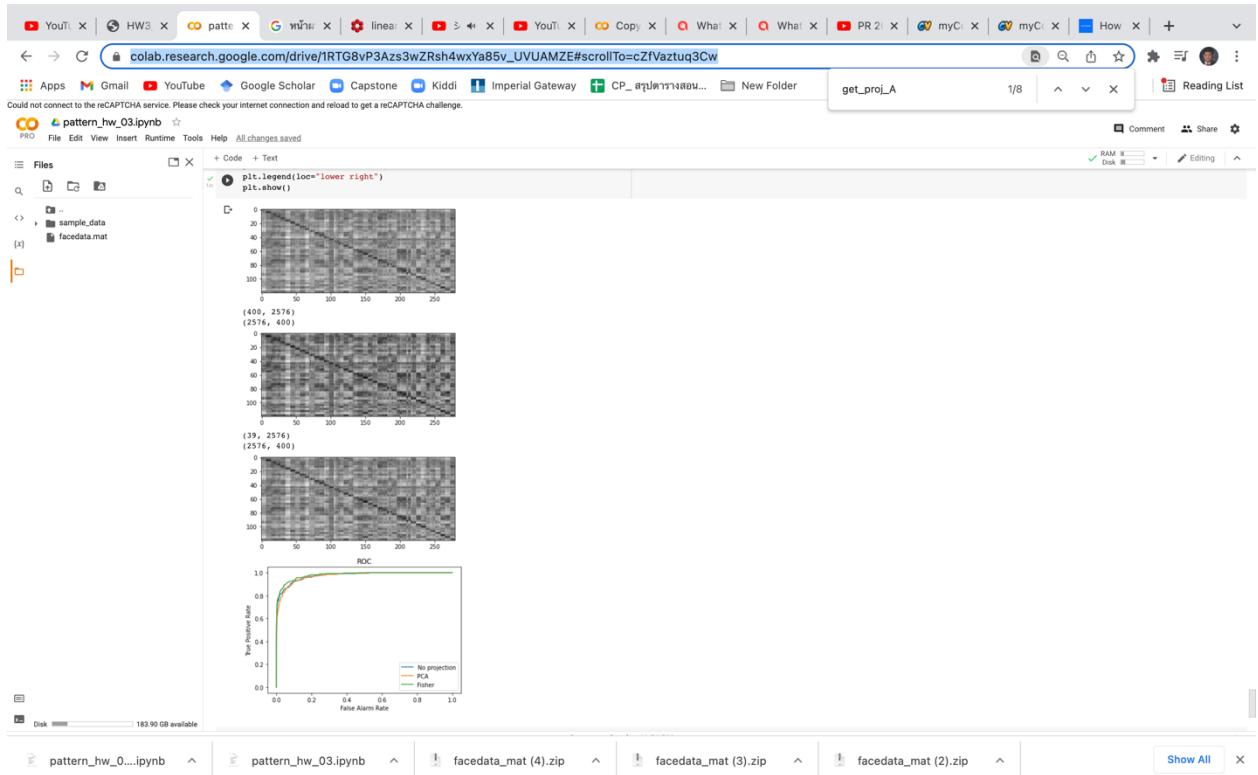
    tp_rate_LDA, fa_rate_LDA = get_tp_fa(A_LDA, t)
    tp_rate_list_LDA.append(tp_rate_LDA)
    fa_rate_list_LDA.append(fa_rate_LDA)

tp_rate_list, fa_rate_list = np.array(tp_rate_list), np.array(fa_rate_list)
tp_rate_list_PCA, fa_rate_list_PCA = np.array(tp_rate_list_PCA), np.array(fa_rate_list_PCA)
tp_rate_list_LDA, fa_rate_list_LDA = np.array(tp_rate_list_LDA), np.array(fa_rate_list_LDA)
plt.plot(tp_rate_list, tp_rate_list, label="No projection")
plt.plot(tp_rate_list_PCA, tp_rate_list_PCA, label="PCA")
plt.plot(tp_rate_list_LDA, tp_rate_list_LDA, label="Fisher")
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.legend(loc="lower right")
plt.show()

```

Disk 183.90 GB available

pattern_hw_0....ipynb **pattern_hw_03.ipynb** **facedata_mat (4).zip** **facedata_mat (3).zip** **facedata_mat (2).zip**



Looking along the false alarm rate axis, we can see that the Fisher method is better than the others clearly. This may be due to the Fisher algo. incorporate the class of the data into its consideration. However, it seems that the PCA at k=10 underperforms the no projection method. To my mind, this is owing to the number of eigen vectors which were used was too small.