

1. The result is recorded in the following table:

	Data Pair 1	Data Pair 2	Data Pair 3
Model 1	0.22	0.23	0.11
Model 2	0.17	0.55	0.45
Model 3	0.24	0.55	0.05

The table shows that Model 1 has a very nice consistency. Model 2 and Model 3 perform very poorly for some pairs. I think this is because Model 2 and Model 3 make assumptions that violate the true population distribution. Model 2 assumes $S1 = S2$, and Model 3 averaged the variance of all parameters within a class. The classes can have different variance and the parameters can have different variance. Making these assumptions can lead to information loss and thus inaccurate predictions.

(parameters calculated is show in appendix)

2. (a)

```
>> script_2a
k = 1  error rate :
      0.0539

k = 3  error rate :
      0.0404

k = 5  error rate :
      0.0438

k = 7  error rate :
      0.0539
```

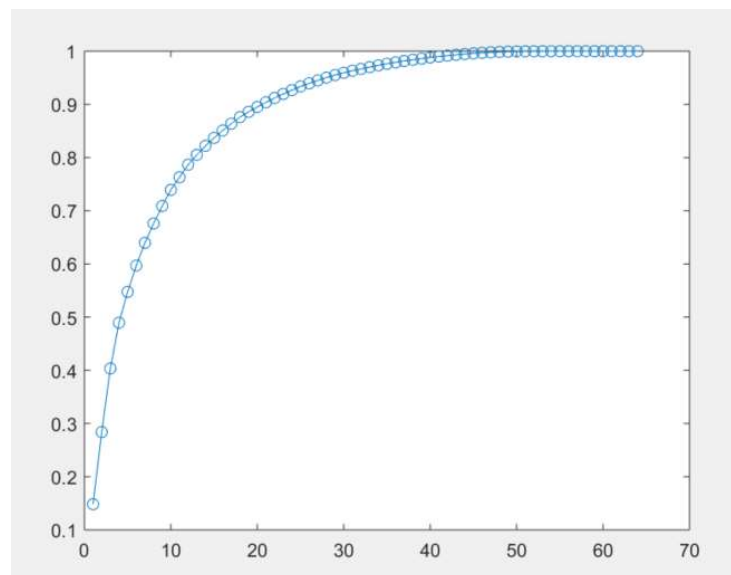
(b)

```
>> script_2b
min number of principle components that covers 0.9 variance: 21
k = 1  error rate :
      0.0471

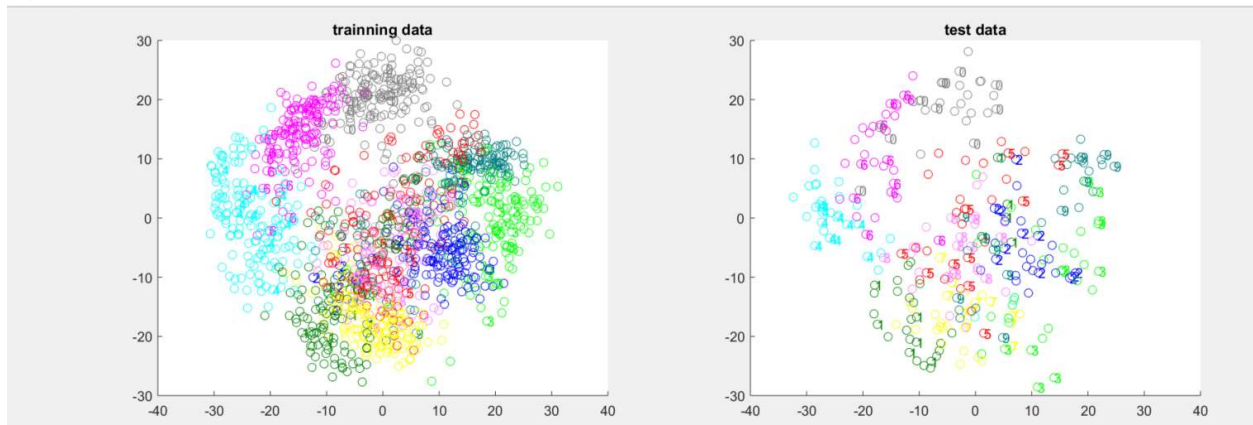
k = 3  error rate :
      0.0471

k = 5  error rate :
      0.0539

k = 7  error rate :
      0.0539
```



(c)



(d)

```
>> script_2d
L = 2, k = 1    error rate :
                0.4478

L = 2, k = 3    error rate :
                0.4175

L = 2, k = 5    error rate :
                0.4074

L = 4, k = 1    error rate :
                0.1953

L = 4, k = 3    error rate :
                0.1852

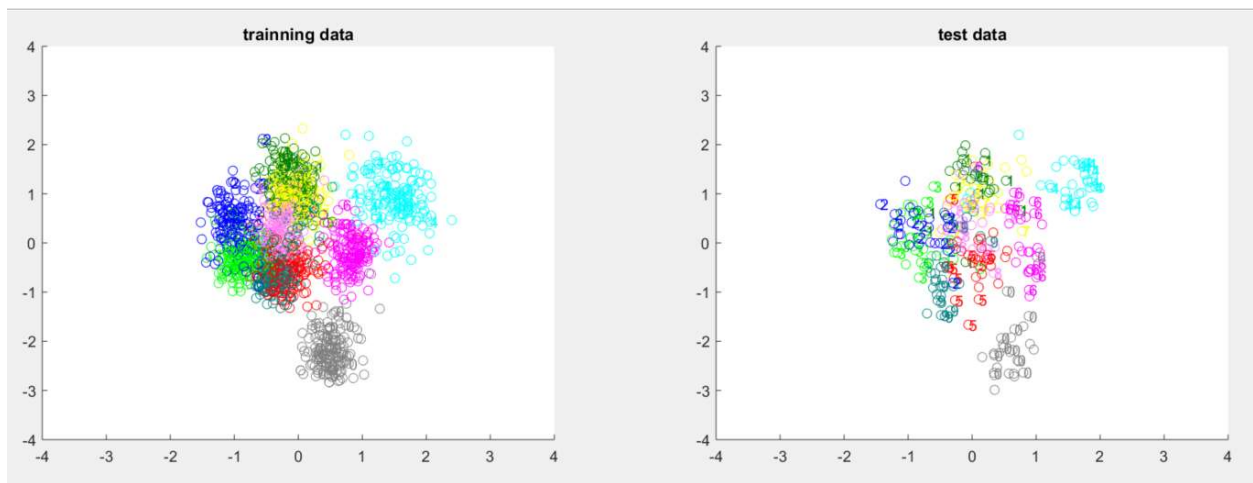
L = 4, k = 5    error rate :
                0.1650

L = 9, k = 1    error rate :
                0.0976

L = 9, k = 3    error rate :
                0.0909

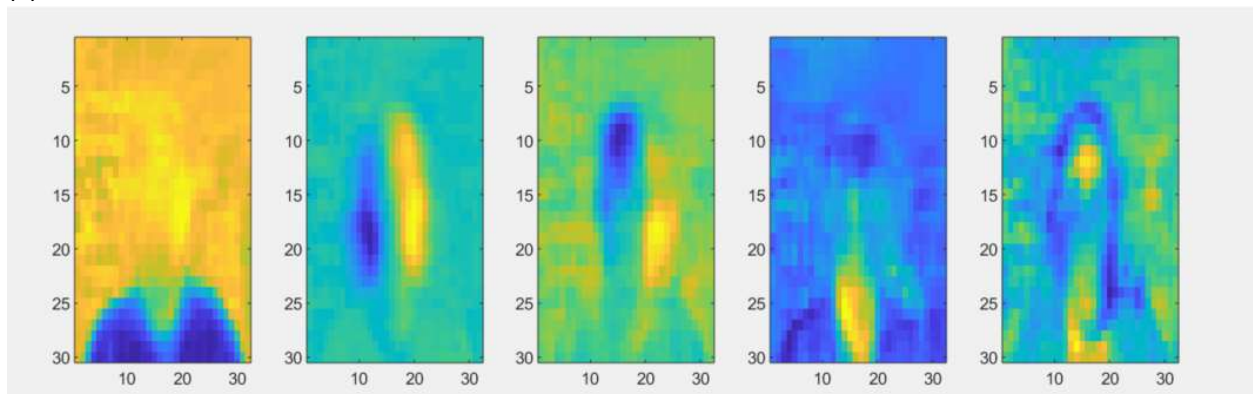
L = 9, k = 5    error rate :
                0.0943
```

(e)



3.

(a)



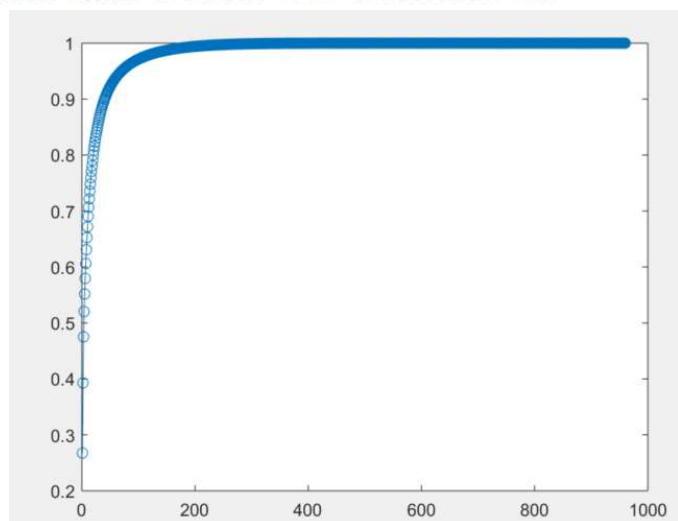
(b)

```
>> script_3b
min number of principle components that covers 0.9 variance: 41
k = 1   error rate :
      0.0968

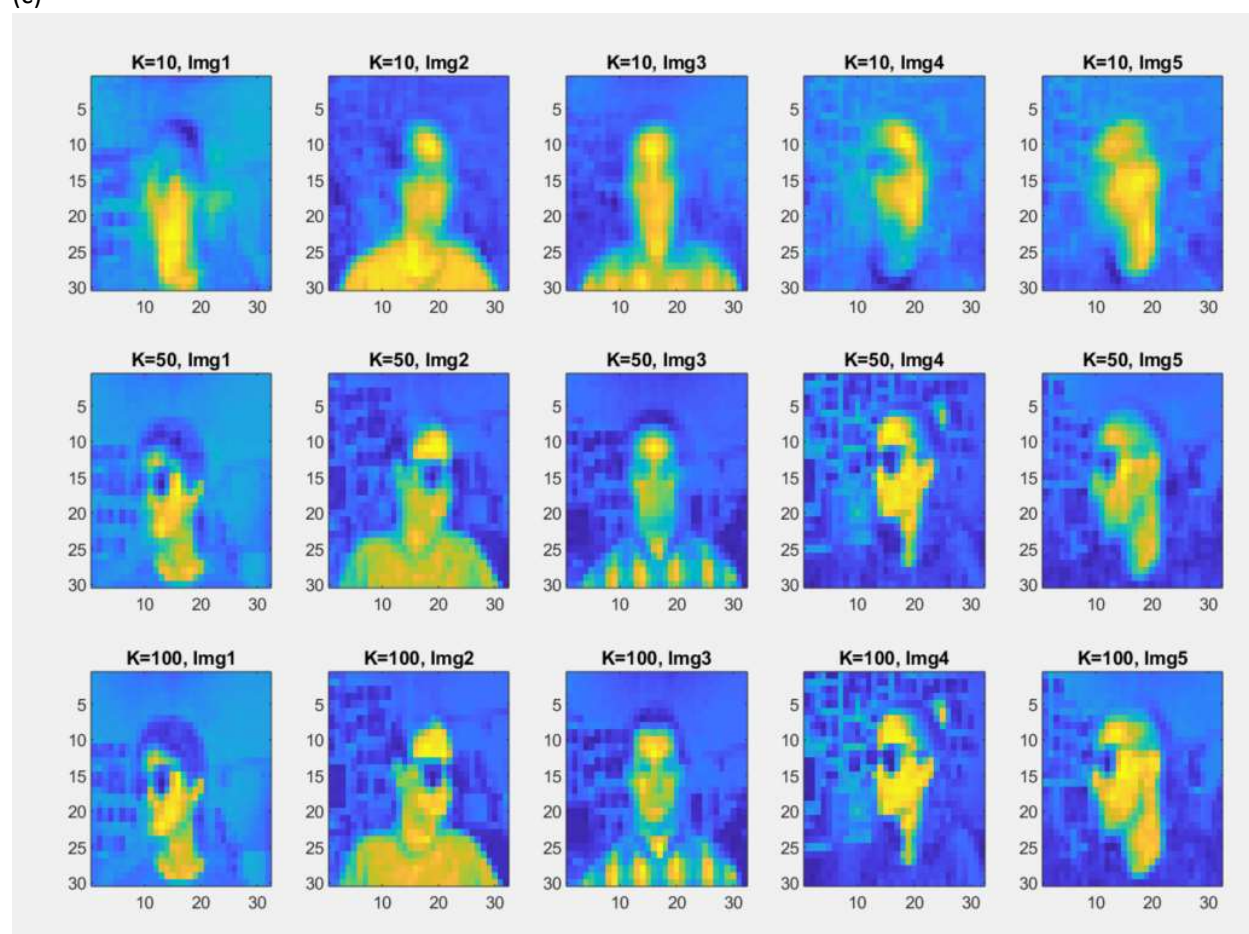
k = 3   error rate :
      0.2339

k = 5   error rate :
      0.4194

k = 7   error rate :
      0.4113
```



(c)



Appendix

Data Pair 1:

$P(C1)=0.30$, $P(C2)=0.70$

mu1:

0.4306 2.0235 3.1758 -2.4272 -2.5234 3.2378 -5.5208 -6.6921

mu2:

4.5841 6.4933 6.4265 1.6891 2.2943 8.3626 -0.1658 -1.8048

Model 1:

S1

1.8640	0.2267	0.7462	0.9977	0.4178	1.2227	1.1337	-1.1909
0.2267	3.5370	0.3019	-0.1300	1.5294	0.9958	-0.1878	3.1664
0.7462	0.3019	7.8426	1.2902	-0.4143	1.7198	0.3431	0.2243
0.9977	-0.1300	1.2902	4.0886	0.9166	0.7222	1.0326	1.9150
0.4178	1.5294	-0.4143	0.9166	3.9976	0.9693	-0.5271	3.3238
1.2227	0.9958	1.7198	0.7222	0.9693	3.9339	-0.1894	2.2238
1.1337	-0.1878	0.3431	1.0326	-0.5271	-0.1894	4.0757	-1.6529
-1.1909	3.1664	0.2243	1.9150	3.3238	2.2238	-1.6529	16.5256

S2

3.4237	2.0692	2.5707	2.6127	1.7732	1.8303	2.6792	2.9340
2.0692	5.7835	2.1793	2.7182	3.1575	2.8877	2.7564	5.8537
2.5707	2.1793	8.7126	3.3752	2.8256	2.2294	2.7535	5.1835
2.6127	2.7182	3.3752	8.1683	3.5774	2.6607	2.0204	8.3968
1.7732	3.1575	2.8256	3.5774	5.5677	2.9061	3.2500	4.8208
1.8303	2.8877	2.2294	2.6607	2.9061	3.7294	2.2349	4.4766
2.6792	2.7564	2.7535	2.0204	3.2500	2.2349	8.2148	4.3055
2.9340	5.8537	5.1835	8.3968	4.8208	4.4766	4.3055	19.8477

Model 2:

S1

2.9558	1.5164	2.0233	2.1282	1.3666	1.6480	2.2156	1.6965
1.5164	5.1096	1.6161	1.8637	2.6690	2.3201	1.8731	5.0475
2.0233	1.6161	8.4516	2.7497	1.8536	2.0765	2.0304	3.6957
2.1282	1.8637	2.7497	6.9444	2.7792	2.0791	1.7240	6.4523
1.3666	2.6690	1.8536	2.7792	5.0966	2.3251	2.1169	4.3717
1.6480	2.3201	2.0765	2.0791	2.3251	3.7908	1.5076	3.8007
2.2156	1.8731	2.0304	1.7240	2.1169	1.5076	6.9731	2.5180
1.6965	5.0475	3.6957	6.4523	4.3717	3.8007	2.5180	18.8511

S2

2.9558	1.5164	2.0233	2.1282	1.3666	1.6480	2.2156	1.6965
1.5164	5.1096	1.6161	1.8637	2.6690	2.3201	1.8731	5.0475
2.0233	1.6161	8.4516	2.7497	1.8536	2.0765	2.0304	3.6957
2.1282	1.8637	2.7497	6.9444	2.7792	2.0791	1.7240	6.4523
1.3666	2.6690	1.8536	2.7792	5.0966	2.3251	2.1169	4.3717
1.6480	2.3201	2.0765	2.0791	2.3251	3.7908	1.5076	3.8007
2.2156	1.8731	2.0304	1.7240	2.1169	1.5076	6.9731	2.5180
1.6965	5.0475	3.6957	6.4523	4.3717	3.8007	2.5180	18.8511

Model 3:

alpha1
5.7331

alpha2
7.9310

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Data pair 2:

```
P(C1)=0.30, P(C2)=0.70
mul:
  1.0658    2.6548    3.2977   -1.6793   -1.4987    4.3959   -4.2138   -4.9679

mu2:
  2.8221    4.4669    4.8537    0.5192    0.3764    6.2585   -2.6611   -3.8175
```

Model 1:

```
S1
  1.3355  -0.2649  0.6608  0.2725  0.9973  0.4623  -0.2879  0.2938
 -0.2649  2.5453  2.0657  0.9204  1.0862  -0.4459  -0.0506  2.6920
  0.6608  2.0657  6.9133  1.5145  0.8146  0.1927  2.6834  2.7168
  0.2725  0.9204  1.5145  3.0526  0.6584  -0.4640  0.2391  2.3010
  0.9973  1.0862  0.8146  0.6584  2.1990  -0.0037  -0.5659  0.7485
  0.4623  -0.4459  0.1927  -0.4640  -0.0037  1.2053  0.6576  -0.1986
 -0.2879  -0.0506  2.6834  0.2391  -0.5659  0.6576  4.0462  -0.7298
  0.2938  2.6920  2.7168  2.3010  0.7485  -0.1986  -0.7298  10.4733

S2
  2.9283  1.0700  2.9092  0.5704  -0.0910  0.0666  0.8741  1.7632
  1.0700  4.9901  2.4537  0.1758  2.7315  -0.3235  0.4943  0.0507
  2.9092  2.4537  11.6572  0.0882  0.8252  0.1275  0.0219  -0.8332
  0.5704  0.1758  0.0882  5.3310  0.0541  1.0103  4.3004  2.2958
 -0.0910  2.7315  0.8252  0.0541  4.2550  1.0248  0.5376  1.6681
  0.0666  -0.3235  0.1275  1.0103  1.0248  2.6892  1.7066  2.1595
  0.8741  0.4943  0.0219  4.3004  0.5376  1.7066  11.3170  2.7119
  1.7632  0.0507  -0.8332  2.2958  1.6681  2.1595  2.7119  12.9317
```

Model 2:

```
S1
  2.4505  0.6695  2.2347  0.4810  0.2355  0.1853  0.5255  1.3224
  0.6695  4.2567  2.3373  0.3992  2.2379  -0.3602  0.3308  0.8431
  2.2347  2.3373  10.2340  0.5161  0.8221  0.1471  0.8204  0.2318
  0.4810  0.3992  0.5161  4.6474  0.2353  0.5680  3.0820  2.2974
  0.2355  2.2379  0.8221  0.2353  3.6382  0.7162  0.2065  1.3922
  0.1853  -0.3602  0.1471  0.5680  0.7162  2.2440  1.3919  1.4521
  0.5255  0.3308  0.8204  3.0820  0.2065  1.3919  9.1358  1.6794
  1.3224  0.8431  0.2318  2.2974  1.3922  1.4521  1.6794  12.1942

S2
  2.4505  0.6695  2.2347  0.4810  0.2355  0.1853  0.5255  1.3224
  0.6695  4.2567  2.3373  0.3992  2.2379  -0.3602  0.3308  0.8431
  2.2347  2.3373  10.2340  0.5161  0.8221  0.1471  0.8204  0.2318
  0.4810  0.3992  0.5161  4.6474  0.2353  0.5680  3.0820  2.2974
  0.2355  2.2379  0.8221  0.2353  3.6382  0.7162  0.2065  1.3922
  0.1853  -0.3602  0.1471  0.5680  0.7162  2.2440  1.3919  1.4521
  0.5255  0.3308  0.8204  3.0820  0.2065  1.3919  9.1358  1.6794
  1.3224  0.8431  0.2318  2.2974  1.3922  1.4521  1.6794  12.1942
```

Model 3:

```
alpha1
  3.9713

alpha2
  7.0124
```

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Data Pair 3:

$P(C1)=0.30$, $P(C2)=0.70$

mu1:

0.9747 2.6233 3.1770 -1.4652 -1.3053 4.5160 -4.3197 -5.5215

mu2:

1.4916 3.1655 3.6504 -0.8162 -0.3515 5.1345 -3.2770 -4.7293

Model 1:

S1

0.2555	0.0816	0.0591	-0.0825	-0.0058	-0.0738	-0.0155	0.0778
0.0816	0.4116	-0.0821	-0.1016	-0.0118	-0.0866	0.1126	-0.0733
0.0591	-0.0821	0.5861	-0.0364	-0.0894	-0.0322	0.0797	0.0128
-0.0825	-0.1016	-0.0364	0.4254	-0.0344	-0.1398	-0.1010	0.0721
-0.0058	-0.0118	-0.0894	-0.0344	0.4183	0.0516	-0.0964	0.0137
-0.0738	-0.0866	-0.0322	-0.1398	0.0516	0.5746	0.0684	-0.0237
-0.0155	0.1126	0.0797	-0.1010	-0.0964	0.0684	0.5261	-0.0294
0.0778	-0.0733	0.0128	0.0721	0.0137	-0.0237	-0.0294	0.3849

S2

2.7546	0.4051	-0.3791	0.5899	-0.4070	0.1636	0.3523	-0.4814
0.4051	2.5008	-0.3447	-0.0362	-0.2919	0.0578	0.1757	0.0869
-0.3791	-0.3447	2.1297	-0.2523	-0.0483	-0.0299	0.0352	-0.2797
0.5899	-0.0362	-0.2523	2.9260	-0.8652	0.1012	-0.3376	-0.3223
-0.4070	-0.2919	-0.0483	-0.8652	3.4593	0.0735	-0.7518	0.1914
0.1636	0.0578	-0.0299	0.1012	0.0735	2.8776	0.6332	0.3468
0.3523	0.1757	0.0352	-0.3376	-0.7518	0.6332	2.9057	0.2744
-0.4814	0.0869	-0.2797	-0.3223	0.1914	0.3468	0.2744	2.5750

Model 2:

S1

2.0048	0.3080	-0.2476	0.3882	-0.2866	0.0924	0.2419	-0.3136
0.3080	1.8741	-0.2660	-0.0558	-0.2079	0.0145	0.1568	0.0388
-0.2476	-0.2660	1.6666	-0.1875	-0.0607	-0.0305	0.0486	-0.1920
0.3882	-0.0558	-0.1875	2.1758	-0.6160	0.0289	-0.2666	-0.2040
-0.2866	-0.2079	-0.0607	-0.6160	2.5470	0.0670	-0.5552	0.1381
0.0924	0.0145	-0.0305	0.0289	0.0670	2.1867	0.4638	0.2357
0.2419	0.1568	0.0486	-0.2666	-0.5552	0.4638	2.1918	0.1832
-0.3136	0.0388	-0.1920	-0.2040	0.1381	0.2357	0.1832	1.9180

S2

2.0048	0.3080	-0.2476	0.3882	-0.2866	0.0924	0.2419	-0.3136
0.3080	1.8741	-0.2660	-0.0558	-0.2079	0.0145	0.1568	0.0388
-0.2476	-0.2660	1.6666	-0.1875	-0.0607	-0.0305	0.0486	-0.1920
0.3882	-0.0558	-0.1875	2.1758	-0.6160	0.0289	-0.2666	-0.2040
-0.2866	-0.2079	-0.0607	-0.6160	2.5470	0.0670	-0.5552	0.1381
0.0924	0.0145	-0.0305	0.0289	0.0670	2.1867	0.4638	0.2357
0.2419	0.1568	0.0486	-0.2666	-0.5552	0.4638	2.1918	0.1832
-0.3136	0.0388	-0.1920	-0.2040	0.1381	0.2357	0.1832	1.9180

Model 3:

alpha1

0.4478

alpha2

2.7661