

HW2

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St2972

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$$\text{Problem 1. (a)} P\{y_i | x, w_1, \dots, w_k\} = \prod_{i=1}^k \left(\frac{e^{x_i^T w_i}}{\sum_{j=1}^k e^{x_j^T w_j}} \right)^{I(y_i=i)} = \frac{e^{x_i^T w_i}}{\sum_{j=1}^k e^{x_j^T w_j}}$$

$$\begin{aligned} \text{log likelihood } L &= \log \prod_{i=1}^n P\{y_i | x, w_1, \dots, w_k\} \\ &= \sum_{i=1}^n \sum_{j=1}^k x_i^T w_j I(y_i=j) - \sum_{i=1}^n \log \sum_{j=1}^k e^{x_j^T w_i} \end{aligned}$$

$$(b) \quad \nabla_{w_i} L = \sum_{i=1}^n x_i I(y_i=i) - \sum_{i=1}^n \frac{x_i e^{x_i^T w_i}}{\sum_{j=1}^k e^{x_j^T w_i}}$$

$$\nabla_{w_i^2} L = - \sum_{i=1}^n \frac{x_i^2 e^{x_i^T w_i} \sum_{j=1}^k e^{x_j^T w_i} - (x_i e^{x_i^T w_i})^2}{(\sum_{j=1}^k e^{x_j^T w_i})^2}$$

Problem 2.

$$\int_{R^2} \phi_t(u) \phi_t(v) dt = \int_{R^2} \frac{1}{(2\pi v)^2} \exp\left\{-\frac{\|u-t\|^2}{2v}\right\} \frac{1}{(2\pi u)^2} \exp\left\{-\frac{\|v-t\|^2}{2u}\right\} dt$$

$$= \frac{1}{(2\pi u)^2} \int_{R^2} \exp\left\{-\frac{\|u-t\|^2 + \|v-t\|^2}{2u}\right\} dt$$

$$= \frac{1}{(2\pi u)^2} \int_{R^2} \exp\left\{-\frac{(u-t)^T(u-t) + (v-t)^T(v-t)}{2u}\right\} dt$$

$$= \frac{1}{(2\pi u)^2} \int_{R^2} \exp\left\{-\frac{u^T u + v^T v}{2u}\right\} \int_{R^2} \exp\left\{-\frac{(u-t)^T(u-t) + (v-t)^T(v-t)}{2u}\right\} dt$$

$$= \frac{1}{(4\pi u)^2} \exp\left\{-\frac{u^T u + v^T v}{2u} + \frac{\|u-v\|^2}{4u}\right\} \int_{R^2} \frac{1}{(2\pi u)^2} \exp\left\{-\frac{\|t - \frac{u+v}{2}\|^2}{2u}\right\} dt$$

$$\therefore \int_{R^2} \frac{1}{(2\pi u)^2} \exp\left\{-\frac{\|u-v-t\|^2}{2u}\right\} dt \rightarrow t \sim N\left(\frac{u+v}{2}, \frac{u}{2}\right)$$

$$\therefore \int_{R^2} \frac{1}{(2\pi u)^2} \exp\left\{-\frac{\|u-v-t\|^2}{2u}\right\} dt = 1.$$

$$\therefore \int_{R^2} \phi_t(u) \phi_t(v) dt = \frac{1}{(4\pi u)^2} \exp\left\{-\frac{\|u-v\|^2}{4u}\right\}$$

$$d = \frac{1}{(4\pi u)^2} \quad \beta = 4u.$$

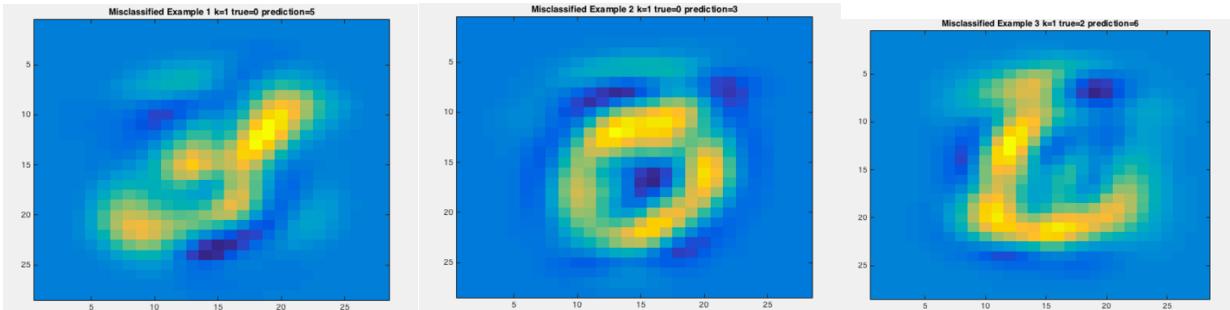
Problem3

(a)

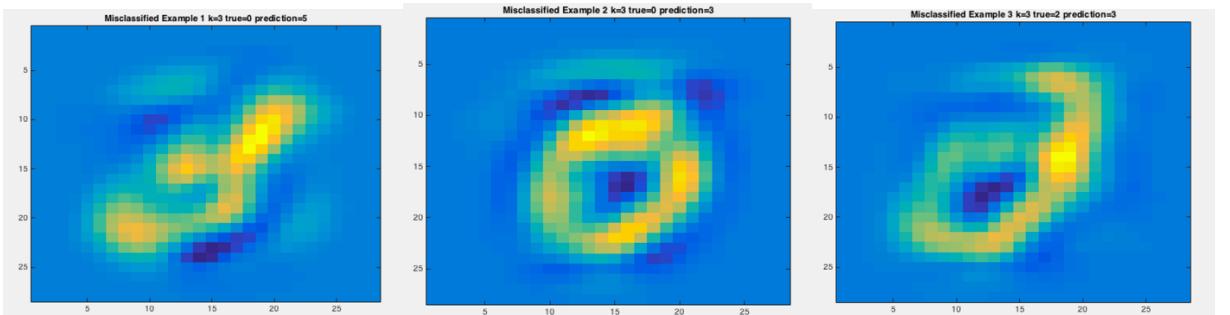
1.

K	accuracy
1	0.9480
2	0.9300
3	0.9380
4	0.9460
5	0.9460

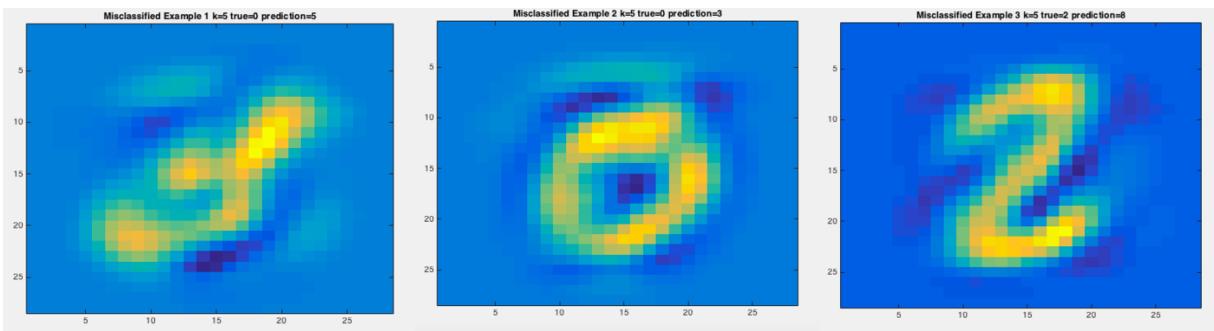
k=1



k=3



k=5



(b)

class prior:

out =

0	1.0000	2.0000	3.0000	4.0000	5.0000	6.0000	7.0000	8.0000	9.0000
0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000

Class 0: Mean:

Covariance:

-3.5257	-0.3891	0.5939	1.1696	-0.7620	-0.3447	1.0989	-0.3333	-0.9181	-0.3235	0.0285	0.3255	-0.1732	-0.0291	0.2357	0.1387	0.2466	0.2411	0.0252	-0.1059
0.8716	0.0954	0.0079	-0.0834	-0.1052	0.1903	-0.2379	0.2759	0.0976	0.1273	0.0570	-0.1669	0.0025	-0.1637	-0.0205	0.0275	-0.0611	-0.1121	-0.0828	0.0607
0.0954	0.2422	0.1442	-0.0169	-0.1141	0.0798	0.0539	0.0907	-0.1041	0.0119	-0.0552	-0.0896	0.0348	0.0002	0.0313	-0.0315	0.0394	-0.0578	-0.0874	-0.0035
0.0079	0.1442	1.1558	0.4324	-0.0955	0.5159	-0.1991	0.4751	-0.2612	-0.0717	0.0346	0.0666	-0.0056	0.2997	-0.0821	-0.0290	0.1794	-0.0633	0.0058	0.0792
-0.0834	-0.1619	0.4324	0.6269	-0.0899	0.3041	-0.2624	0.1855	-0.0515	-0.0105	0.0601	-0.1039	-0.0954	0.1158	0.0005	-0.0816	0.1949	0.0143	0.0847	0.0237
-0.1052	-0.1141	-0.0955	-0.0895	0.4475	-0.3017	-0.0491	-0.2522	-0.0690	-0.2054	0.0887	0.2660	0.0367	0.2161	-0.2770	-0.0066	-0.0122	0.0912	0.1587	-0.0028
0.1903	0.0798	0.5159	0.3041	-0.3017	0.6725	-0.2443	0.2759	0.0259	0.1261	-0.1229	-0.1993	-0.0706	0.0199	0.1452	-0.0442	0.1294	-0.1098	0.0217	0.0229
-0.2379	0.0539	-0.1991	-0.2624	-0.0491	-0.2443	0.4570	-0.0909	-0.1547	-0.0753	-0.0624	0.0574	0.0900	-0.0708	-0.0187	0.0147	-0.1543	0.0264	-0.0703	-0.0796
0.2759	0.0907	0.4751	0.1855	-0.2522	0.2759	-0.0939	0.5675	-0.0910	0.0831	0.0664	-0.0616	-0.0013	-0.0006	0.0784	-0.0070	0.0356	-0.0685	-0.0623	0.0298
0.0976	-0.1041	-0.2612	-0.0515	-0.0690	0.0259	-0.1547	-0.0910	0.4921	0.0889	-0.0511	-0.0708	-0.0675	-0.0123	0.1560	0.0114	-0.0701	0.0225	-0.0010	-0.0050
0.1273	0.0119	-0.0717	-0.0105	-0.2054	0.1261	-0.0753	0.0831	0.0889	0.2044	-0.0442	-0.1236	-0.0583	-0.1677	0.1368	0.0264	0.0422	-0.0407	-0.0559	-0.0077
0.0570	-0.0552	0.0346	0.0601	0.0887	-0.1229	-0.0624	0.0664	-0.0511	-0.0442	0.2663	0.0430	0.0192	0.0058	-0.0992	0.0283	-0.0071	0.0069	0.0035	0.0873
-0.1659	-0.0895	0.0666	-0.1039	0.2660	-0.1993	0.0574	-0.0616	-0.0708	-0.1236	0.0430	0.3059	0.0580	0.1993	-0.1598	0.0512	-0.0286	0.0578	0.0742	0.0102
0.0225	0.0348	-0.0056	-0.0954	0.0367	-0.0708	0.0908	-0.0018	-0.0573	-0.0583	0.0192	0.0580	0.1384	0.0434	-0.0313	0.0102	-0.0546	0.0014	0.0218	0.0065
-0.1637	0.0002	0.2997	0.1158	0.2161	0.0199	-0.0708	-0.0008	-0.0123	-0.1677	0.0058	0.1893	0.0434	0.4020	-0.1015	-0.0395	0.0753	0.0370	0.1156	0.0336
-0.0205	0.0313	-0.0821	0.0205	-0.2770	0.1452	-0.0187	0.0784	0.1560	0.1368	-0.0992	-0.1598	-0.0013	-0.1015	0.3121	-0.0213	0.0126	-0.0412	-0.0470	-0.0251
0.0275	-0.0315	-0.0290	-0.0816	-0.0056	-0.0442	0.0147	-0.0070	0.0114	0.0264	0.0283	0.0512	0.0102	-0.0395	-0.0213	0.1340	-0.0460	-0.0113	-0.0324	0.0309
-0.0611	0.0394	0.1794	0.1949	-0.0122	0.1294	-0.1543	0.0356	-0.0701	0.0422	-0.0071	-0.0286	-0.0546	0.0753	0.0126	-0.0460	0.2547	-0.0281	0.0133	0.0044
-0.1121	-0.0578	-0.0633	0.0143	0.0912	-0.1998	0.0264	-0.0685	0.0225	-0.0407	0.0089	0.0578	0.0014	0.0370	-0.0412	-0.0113	-0.0281	0.1840	0.0327	0.0007
-0.0828	-0.0874	0.0058	0.0847	0.1587	0.0217	-0.0703	-0.0623	-0.0010	-0.0569	0.0035	0.0742	0.0218	0.1156	-0.0470	-0.0324	0.0133	0.0327	0.2131	0.0001
0.0607	-0.0035	0.0792	0.0237	-0.0028	0.0229	-0.0796	0.0298	-0.0050	-0.0077	0.0873	0.0102	0.0065	0.0336	-0.0251	0.0309	0.0044	0.0007	0.0001	0.1178

Class 1: Mean:

Covariance:

0.1832	-0.8916	0.5454	0.7981	-1.3545	-0.2015	1.1495	-0.4419	-1.0389	-0.3145	0.2998	0.4355	0.0235	0.3132	0.5538	0.0306	0.4581	0.4222	0.0284	-0.0549
0.0750	-0.0170	0.0080	-0.0067	0.0517	-0.0036	0.0556	-0.0178	-0.0296	0.0385	0.0214	-0.0098	-0.0805	0.0564	0.0669	0.0031	0.0039	0.0101	-0.0182	0.0028
-0.0170	0.1845	-0.1256	0.0031	0.1122	0.2327	0.1029	-0.0197	0.1962	-0.0428	0.1368	0.1285	0.0414	-0.0977	-0.1013	-0.0523	0.0753	0.0344	0.0179	-0.0640
0.0080	-0.1256	0.1443	0.0019	-0.1299	-0.2390	-0.1137	0.0284	-0.1536	0.0482	-0.1283	-0.0850	-0.0098	0.0630	0.0552	0.0247	-0.0543	-0.0306	0.0069	0.0602
-0.0067	0.0031	0.0119	-0.0867	-0.0600	0.0628	0.1186	-0.0182	-0.0185	-0.0165	0.0539	0.0481	-0.0203	-0.1599	0.0047	0.0029	0.0250	0.0356	0.0018	-0.0037
0.0517	0.1122	-0.1299	-0.0600	0.2624	0.2192	0.0854	-0.0375	0.1599	0.0199	0.1459	0.0372	-0.0508	0.0166	0.0089	-0.0344	0.0251	0.0205	-0.0270	-0.0612
-0.0036	0.2327	-0.2390	0.0628	0.2192	0.6326	0.4134	-0.1060	0.2962	-0.0987	0.4062	0.2319	-0.0014	-0.1477	-0.0692	-0.0599	0.1238	0.1376	-0.0384	-0.1573
0.0556	0.1029	-0.1137	0.1189	0.0854	0.4134	-0.1434	0.4826	-0.1059	0.1287	-0.0221	0.3089	0.1760	-0.1257	-0.163	0.0400	-0.0135	0.0979	0.1516	-0.0348
-0.0178	-0.0197	0.0284	-0.0182	-0.0375	-0.1064	-0.1059	0.0434	-0.0319	-0.0051	-0.0896	-0.0260	0.0228	0.0014	-0.183	0.0058	-0.0185	-0.0305	0.0116	0.0339
-0.0296	0.1962	-0.1536	-0.0189	0.1599	0.2962	0.1287	-0.0310	0.2733	-0.0543	0.1749	0.1524	0.0641	-0.1187	-0.1101	-0.0675	0.0742	0.0498	0.0209	-0.0863
0.0385	-0.0428	0.0482	-0.0165	0.0199	-0.0987	-0.0231	-0.0051	-0.0543	0.0893	-0.0391	-0.0628	-0.0445	0.0706	0.0588	0.0241	-0.0310	-0.0101	-0.0333	0.0107
0.0214	0.1368	-0.1283	0.0539	0.1459	0.4062	0.3089	-0.0896	0.1749	-0.0391	0.3184	0.1556	-0.0220	-0.0854	-0.0113	-0.0547	0.0626	0.0984	-0.0324	-0.1124
-0.0098	0.1285	-0.0850	0.0481	0.0372	0.2319	0.1760	-0.0260	0.1524	-0.0628	0.1556	0.1753	0.0290	-0.0991	-0.0627	-0.0588	0.0792	0.0602	0.0203	-0.0502
-0.0805	0.0414	-0.0098	-0.0203	-0.0508	-0.0014	-0.1257	0.0228	0.0641	-0.0645	-0.0220	0.0290	0.1799	-0.0978	-0.1077	-0.0292	0.0100	-0.0362	0.0340	-0.0078
0.0564	-0.0977	0.0630	-0.0159	0.0166	-0.1477	-0.0163	0.0014	-0.1187	0.0706	-0.0854	-0.0991	-0.0978	0.1319	0.0917	0.0575	-0.0372	-0.0125	-0.0205	0.0258
0.0669	-0.1013	0.0552	0.0047	-0.0692	0.0400	-0.1830	0.1101	0.0585	-0.0113	-0.0627	-0.1077	0.0917	0.1270	0.0320	-0.0377	0.0062	-0.0319	0.0225	
0.0031	-0.0523	0.0247	0.0029	-0.0344	-0.0599	-0.0135	0.0058	-0.0675	0.0241	-0.0547	-0.0588	-0.0292	0.0575	0.0320	0.0586	-0.0229	-0.0076	-0.0107	0.0138
0.0038	0.0753	-0.0543	0.0250	0.0251	0.1238	0.0979	-0.0185	0.0742	-0.0310	0.0826	0.0792	0.0100	-0.0372	-0.0377	-0.0229	0.0593	0.0304	0.0056	-0.0345
0.0101	0.0344	-0.0306	0.0356	0.0205	0.1376	0.1516	-0.0305	0.0498	-0.0101	0.0984	0.0602	-0.0362	-0.0125	0.0062	-0.0076	0.0304	0.0706	-0.0101	-0.0363
-0.0182	0.0179	0.0069	0.0018	-0.0270	-0.0384	-0.0348	0.0116	0.0209	-0.0033	-0.0324	0.0203	0.0340	-0.0205	0.0319	-0.0107	0.0056	-0.0101	0.0336	0.0086
0.0038	-0.0640	0.0602	-0.0037	-0.0612	-0.1573	-0.1071	0.0339	-0.0863	0.0107	-0.1124	0.0258	0.0225	0.0138	-0.0345	-0.0363	0.0086	0.0675		

Class 2: Mean:

Covariance:

-1.7275	-0.6510	0.8067	0.1514	-2.3694	-0.6660	1.2293	0.1673	-0.4931	-0.4152	0.3724	0.3473	-0.1608	0.0482	-0.0016	0.1905	0.3605	0.2868	0.1755	-0.1066
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0.6327	-0.0674	-0.3085	-0.0855	0.1087	0.1076	0.0714	-0.1319	-0.1730	0.0374	-0.1793	-0.0199	0.0454	-0.0765	-0.0127	0.0063	-0.0419	-0.0210	0.0539	-0.0028
-0.0674	0.5280	0.1827	-0.0030	0.1033	0.0219	-0.1021	0.0476	-0.0051	0.0021	0.1791	-0.1218	-0.0451	0.0663	-0.0559	-0.0824	0.0762	-0.0321	-0.0817	0.0505
-0.3085	0.1827	0.6964	-0.0438	-0.0247	-0.0476	-0.2826	0.1192	0.1249	-0.1319	0.1546	-0.0078	-0.0607	0.0933	-0.0777	-0.1118	0.1523	0.0902	-0.1932	0.0309
-0.0855	-0.0030	-0.0438	0.3469	0.0226	-0.0975	0.0109	-0.0544	0.0798	0.0219	-0.0291	-0.0660	0.0497	0.0518	0.0588	-0.0073	-0.0580	0.1036	0.0191	0.0050
0.1087	0.1033	-0.0247	0.0226	0.4303	0.1467	-0.1112	-0.0094	0.0286	0.0435	0.0603	-0.0259	0.0778	0.0506	0.0573	0.0286	0.0146	-0.0672	-0.0081	0.0448
0.1076	0.0219	-0.0476	-0.0975	0.1467	0.3355	0.0107	-0.0072	-0.1672	-0.0084	0.0598	0.0591	0.0039	-0.0004	0.0215	0.0066	-0.0201	-0.1439	-0.0112	-0.0228
0.0714	-0.1021	-0.2826	0.0109	-0.1112	0.0107	0.5913	-0.0161	-0.1393	0.0029	-0.0975	-0.0822	0.0211	0.0193	-0.0264	0.1082	-0.0680	-0.1111	0.0990	0.0105
-0.1319	0.0476	0.1192	-0.0544	-0.0094	-0.0072	-0.0161	0.2929	0.1455	0.0816	0.0198	0.0463	-0.1151	-0.0116	0.0165	0.0837	0.0059	0.0022	-0.0261	-0.0327
-0.1730	-0.0051	0.1249	0.0798	0.0286	-0.1672	-0.1333	0.1455	0.4654	0.0968	-0.0110	-0.0039	-0.0132	0.0283	0.0622	0.1013	0.0146	0.1372	-0.0050	0.0040
0.0374	0.0021	-0.1319	0.0219	0.0435	-0.0084	0.0029	0.0816	0.0968	0.2342	-0.0108	0.0514	-0.0309	0.0013	0.0473	0.1072	-0.0510	0.0289	-0.0008	-0.0248
-0.1793	0.1791	0.1546	-0.0291	0.0603	0.0598	-0.0975	0.0198	-0.0110	-0.0108	0.3830	-0.0171	-0.0087	0.0630	-0.0104	-0.0319	0.0872	-0.0738	-0.0524	0.0105
-0.0199	-0.1218	-0.0078	-0.0600	-0.0255	0.0591	-0.0822	0.0463	-0.0056	0.0514	-0.0171	0.2159	-0.0394	-0.0077	0.0198	0.0250	-0.0319	0.0172	0.0043	-0.0642
0.0454	-0.0451	-0.0607	0.0497	0.0776	0.0039	0.0211	-0.1151	-0.0132	-0.0309	-0.0087	-0.0394	0.2541	0.0309	0.0221	-0.0222	-0.0355	0.0087	0.0438	0.0171
-0.0765	0.0663	0.6933	0.0518	0.0606	-0.0004	0.0193	-0.0116	0.0283	-0.0013	0.0630	-0.0077	0.0309	0.2169	-0.0236	-0.0225	0.0277	-0.0162	-0.0229	0.0274
0.0127	-0.0559	-0.0777	0.0586	0.0573	0.0215	-0.0264	0.0165	0.0622	0.0473	-0.0104	0.0198	0.0221	-0.0236	0.2083	0.0558	-0.0469	0.0164	0.0250	-0.0146
0.0063	-0.0824	-0.1118	-0.0073	0.0286	0.0066	0.0182	0.0837	0.1013	0.1072	-0.0319	0.0250	-0.0222	-0.0225	0.0558	0.2198	-0.0287	0.0271	0.0168	-0.0214
-0.0419	0.0762	0.1523	-0.0580	0.0146	-0.0201	-0.0680	0.0059	0.0146	-0.0510	0.0872	-0.0319	-0.0358	0.0277	-0.0469	-0.0287	0.1774	0.0016	-0.0304	0.0225
-0.0210	-0.0321	0.0902	0.1036	-0.0672	-0.1439	-0.1111	0.0022	0.1372	0.0289	-0.0738	0.0172	0.0087	-0.0162	0.0164	0.0271	0.0016	0.2996	0.0036	-0.0288
0.0539	-0.0817	-0.1392	0.0191	-0.0081	-0.0112	0.0990	-0.0261	-0.0050	-0.0008	-0.0524	0.0043	0.0438	-0.0029	0.0250	0.0168	-0.0304	0.0036	0.1761	-0.0087
-0.0028	0.0505	0.0309	0.0050	0.0448	-0.0228	0.0105	-0.0327	0.0040	-0.0248	0.0105	-0.0642	0.0717	0.0274	-0.0146	-0.0214	0.0225	-0.0288	-0.0087	0.1288

Class 3: Mean:

Covariance:

-1.6568	-0.9565	-0.5048	1.4756	-2.0401	-0.0161	0.9467	0.4412	-0.8106	0.0466	0.3707	0.5154	-0.0470	0.2789	0.1143	-0.0008	0.4073	0.2371	0.1864	-0.1341
0.5299	0.2100	0.0063	-0.0982	0.1451	0.0947	-0.0253	-0.1038	0.0541	-0.2002	0.0299	-0.0050	-0.0452	0.0259	0.0231	0.1152	-0.0372	-0.1486	-0.0755	-0.0153
0.2100	0.4428	-0.0020	-0.0090	0.0374	0.0019	-0.1686	-0.2182	-0.0064	-0.1677	0.1384	-0.1090	0.0466	0.0400	-0.0107	-0.0619	-0.0870	-0.1288	-0.0018	-0.0145
0.0063	-0.0020	0.7762	0.1332	0.0267	-0.0593	0.0009	0.2031	0.2235	-0.1709	-0.2366	0.1941	0.0731	0.1579	0.0443	-0.0478	-0.1228	0.1144	-0.1050	0.0018
-0.0982	-0.0090	0.1332	0.3986	-0.1747	-0.0965	-0.0799	0.0660	0.1070	-0.1039	-0.0409	0.0719	-0.0192	0.1579	0.0923	-0.0379	-0.0014	-0.0401	-0.0034	-0.0327
0.1451	0.0374	0.0267	-0.1747	0.4328	0.1483	0.0336	-0.0075	0.0114	0.0585	-0.0532	-0.1081	0.0629	-0.0693	-0.0394	0.0087	0.0384	0.0342	-0.0105	0.0845
0.0947	0.0019	-0.0593	-0.0965	0.1483	0.9921	0.1121	0.0157	-0.1030	0.0271	-0.0108	-0.0583	0.0235	-0.0252	0.0126	0.1133	0.0247	0.0001	-0.0889	0.0155
-0.0253	-0.1688	0.0009	-0.0799	0.0336	0.1121	0.4125	0.0030	-0.1229	-0.0267	-0.0333	-0.0404	0.0292	-0.0595	-0.0211	0.0506	-0.0211	0.0158	-0.0117	0.0199
-0.1038	-0.2182	0.2031	0.0666	-0.0075	0.0157	0.0300	0.3369	0.0745	0.0269	-0.1781	0.0899	0.0013	0.0963	0.0376	0.0164	0.0201	0.0923	-0.0287	0.0033
0.0541	-0.0064	0.2235	0.1070	0.0114	-0.1030	-0.1225	0.0745	0.3342	-0.1076	-0.1039	0.0756	0.0240	0.1362	0.0840	-0.0273	-0.0302	0.0304	-0.0223	-0.0429
-0.0002	-0.1677	-0.1709	-0.1036	0.0595	0.0271	-0.0267	0.0269	-0.1076	0.3669	0.0333	-0.0151	0.0157	-0.1269	-0.0398	-0.0466	0.0560	0.0978	0.0539	-0.0599
0.0299	0.1384	-0.0286	-0.0403	-0.0532	-0.0109	-0.0333	-0.1781	-0.1039	0.0333	0.3487	-0.0927	-0.0102	-0.0531	-0.0784	-0.0065	-0.0119	-0.0828	0.0517	-0.0175
-0.0050	-0.1050	0.1941	0.0719	-0.1081	-0.0583	-0.0404	0.0989	0.0756	-0.0151	-0.0927	0.2398	-0.0211	0.0530	0.0276	0.0245	-0.0483	0.0315	-0.0288	-0.0378
-0.0452	0.0466	0.0731	-0.0192	0.0629	0.0235	0.0392	0.0013	0.0240	0.0157	-0.0102	-0.0211	0.1680	0.0202	-0.0216	-0.0672	-0.0237	0.0501	0.0116	0.0274
0.0253	0.0400	0.1579	0.1578	-0.0693	-0.0252	-0.0595	0.0963	0.1262	-0.1265	-0.0531	0.0630	0.0202	0.2529	0.0662	-0.0542	-0.0506	-0.0401	0.0149	-0.0143
0.0231	-0.0107	0.0443	0.0923	0.0154	-0.0211	0.0376	0.0840	-0.0838	-0.0784	0.0276	-0.0216	0.0652	0.1822	0.0201	-0.0046	0.0416	0.0252	-0.0400	-0.0400
0.1152	-0.0619	-0.0478	-0.0379	0.0087	0.1133	0.0506	0.0164	-0.0273	-0.0466	0.0245	-0.0572	0.0542	0.0201	0.2543	0.0424	0.0114	-0.0269	-0.0363	-0.0327
-0.0372	-0.0870	-0.1228	-0.0014	0.0384	0.0247	-0.0211	0.0201	-0.0302	0.0560	-0.0119	-0.0483	-0.0237	-0.0506	-0.0046	0.0424	0.1897	0.0014	-0.0444	0.0333
-0.1486	-0.1288	0.1144	-0.0401	0.0342	0.0001	0.0158	0.0923	0.0304	0.0878	-0.0828	0.0135	0.0501	-0.0401	-0.0416	0.0114	0.0014	0.2294	0.0061	0.0233
-0.0755	-0.0018	-0.1050	-0.0034	-0.0105	-0.0089	-0.0117	-0.0287	-0.0323	0.0539	0.0517	-0.0288	0.0116	-0.0149	0.0252	-0.0269	-0.0044	0.0061	0.1892	-0.0311
-0.0153	-0.0145	0.0018	-0.0327	0.0845	0.0155	0.0199	0.0033	-0.0429	0.0589	-0.0175	-0.0378	0.0274	-0.0143	-0.0400	-0.0363	0.0333	0.0233	-0.0311	0.1459

Class 4: Mean:

Covariance:

-1.4239	1.1576	0.4040	0.5857	-2.1240	-0.1338	0.3267	-0.1740	-0.9415	0.0329	0.2459	0.7152	-0.0771	0.1628	0.2902	0.2615	0.4633	0.4016	0.2114	0.0551
0.5862	-0.2659	0.0296	0.2078	0.0528	0.0869	0.0641	-0.0220	0.0542	0.0637	-0.1991	-0.0317	-0.1341	-0.0796	-0.1715	0.0154	-0.0549	-0.0072	0.0054	0.0562
-0.2659	0.3177	-0.0272	-0.0041	-0.0777	-0.0513	-0.0425	-0.0031	0.0963	-0.0226	0.0657	0.1217	0.0566	0.0143	0.1227	0.0423	0.0047	0.0209	-0.0059	-0.0189
0.																			

0.6551	0.1477	0.5009	-0.1168	0.2250	-0.0704	-0.0461	0.1370	-0.0744	-0.1184	0.0314	0.0782	0.0739	-0.2419	-0.0619	0.1313	-0.0087	-0.1841	-0.0466	-0.1904
0.1477	0.3464	0.1147	0.0615	0.0396	-0.0435	-0.0617	-0.1097	-0.1353	-0.1397	0.0286	0.0235	-0.0383	-0.0815	0.0184	0.1500	-0.0112	-0.1350	0.0720	-0.1328
0.5009	0.1147	0.0344	0.1306	0.1619	0.0318	0.0490	0.2776	-0.2204	-0.2073	-0.0812	0.2127	0.1106	-0.2069	-0.1110	0.1927	-0.0719	-0.1497	0.0513	-0.2796
-0.1168	0.0615	0.1306	0.6824	-0.1025	0.1159	-0.0364	-0.0446	0.0043	-0.2100	0.0509	-0.0073	-0.0737	0.1433	-0.0088	0.1040	-0.0532	-0.0518	0.2249	-0.0304
0.2250	0.0396	0.1619	-0.1025	0.2835	-0.0969	0.0061	0.0942	-0.0460	0.0226	-0.0536	0.0368	0.0583	-0.1291	-0.0307	-0.0054	0.0217	-0.0311	-0.0050	-0.0386
-0.0704	-0.0435	0.0312	0.1159	-0.0969	0.2495	-0.0239	0.0391	0.1162	-0.0444	-0.0503	-0.0317	-0.0253	0.1026	0.0189	-0.0403	-0.0504	0.0591	0.0463	-0.0031
-0.0461	-0.0617	0.0490	-0.0364	0.0061	-0.0239	0.2455	0.0741	-0.0226	0.0323	-0.0514	0.0303	0.0794	-0.0477	0.0112	-0.0069	0.0064	0.0460	-0.0373	0.0135
0.1370	-0.1097	0.2776	-0.0446	0.0942	0.0391	0.0741	0.3857	-0.0545	0.0254	-0.0837	0.0847	0.1321	0.0006	-0.0803	-0.0538	-0.0143	0.0225	-0.0572	-0.0680
-0.0744	-0.1933	-0.2204	0.0043	-0.0460	0.1162	-0.0236	-0.0545	0.3596	-0.0115	-0.0287	-0.0955	-0.0427	0.1354	0.0573	-0.0967	0.0155	0.0510	0.0115	0.1002
-0.1184	-0.1397	-0.2073	-0.2100	0.0226	-0.0444	0.0323	0.0254	-0.0218	0.3392	-0.0372	0.0221	0.0412	-0.0039	-0.0130	-0.1367	0.0525	0.0525	-0.0862	0.0799
0.0314	0.0286	-0.0812	0.0509	-0.0539	-0.0505	-0.0514	-0.0837	-0.0287	-0.0372	0.1688	-0.0225	-0.0802	-0.0039	-0.0131	0.0255	-0.0282	-0.0274	0.0214	0.0298
0.0782	0.0235	0.2127	-0.0073	0.0368	-0.0317	0.0303	0.0847	-0.0955	0.0221	-0.0225	0.2217	0.0513	-0.0608	0.0151	0.0871	-0.0416	-0.0237	-0.0220	-0.0769
0.0738	-0.0383	0.1106	-0.0737	0.0583	-0.0253	0.0794	0.1321	-0.0427	0.0412	-0.0802	0.0513	0.1775	-0.0474	-0.0174	-0.0046	0.0501	-0.0027	-0.0497	-0.0486
-0.2419	-0.0815	-0.2069	0.1433	-0.1291	0.1026	-0.0477	0.0006	0.1354	-0.0039	-0.0608	-0.0474	0.3256	-0.0080	-0.0834	-0.0555	0.0849	0.0257	0.0778	
-0.0619	0.0184	-0.1110	-0.0088	-0.0307	0.0189	0.0112	-0.0803	0.0573	-0.0130	-0.0131	-0.0151	-0.0174	-0.0080	0.1651	0.0002	0.0277	0.0121	0.0649	0.0308
0.1313	0.1500	0.1927	0.1040	-0.0054	-0.0403	-0.0609	-0.0538	-0.0967	-0.1367	0.0255	0.0871	-0.0046	-0.0834	0.0002	0.3136	-0.0551	-0.0798	0.0835	-0.1395
-0.0087	-0.0112	-0.0719	-0.0532	0.0217	-0.0504	0.0064	0.0143	0.0155	0.0525	-0.0282	-0.0416	0.0501	0.0555	0.0277	-0.0551	0.2021	-0.0218	-0.0231	0.0309
-0.1841	-0.1350	-0.1497	-0.0518	-0.0311	0.0591	0.0480	0.0225	0.0510	0.0525	-0.0274	-0.0237	-0.0027	0.0849	0.0121	-0.0798	-0.0218	0.1941	-0.0302	0.1029
-0.0466	0.0720	0.0513	0.2249	-0.0050	0.0463	-0.0373	-0.0572	0.0115	-0.0862	0.0214	-0.0220	-0.0497	0.0257	0.0649	0.0835	-0.0231	-0.0302	0.2586	-0.0426
-0.1904	-0.1328	-0.2796	-0.0304	-0.0386	-0.0031	0.0135	-0.0680	0.1002	0.0799	0.0298	-0.0769	-0.0488	0.0778	0.0308	-0.1395	0.0309	0.1029	-0.0426	0.2755

Class 6: Mean:

Covariance:

-1.9535	-0.0325	0.9800	-0.0514	-2.1983	0.8582	1.2240	-0.3137	-0.8244	0.0217	0.1006	0.2761	0.1396	0.2583	0.2289	0.0682	0.0193	0.2810	0.1587	0.1536
0.6968	-0.1399	-0.0017	0.2382	0.1053	0.0552	-0.2287	0.2362	0.0511	-0.1273	0.1932	-0.1293	0.0377	-0.0496	0.0219	0.1026	-0.1657	-0.0201	0.0147	0.0046
-0.1399	0.2786	-0.0398	-0.2424	-0.0017	-0.0919	0.1204	-0.0726	0.1214	0.0986	-0.0620	0.0805	0.0260	0.0901	-0.0516	-0.0118	0.1516	-0.0961	0.0349	-0.0087
-0.0017	-0.0398	0.4801	0.1993	-0.0892	0.2285	0.0160	0.1325	-0.1095	-0.1423	0.1089	-0.2075	-0.1685	-0.0158	-0.0145	-0.0313	0.0476	0.0795	-0.1271	0.0830
0.2382	-0.2424	0.1993	0.4935	-0.0300	0.2800	-0.1714	0.1899	-0.0599	-0.1654	0.1176	-0.2239	-0.1013	-0.0832	0.0296	0.0661	-0.1194	-0.0685	0.0280	
0.1053	-0.0017	-0.0892	-0.0360	0.3843	-0.1850	-0.0460	0.0802	0.0501	-0.0371	-0.0034	0.0479	-0.0504	-0.0502	-0.0383	0.0593	-0.0468	0.0091	-0.0423	0.0267
0.0552	-0.0919	0.2285	0.2800	-0.1850	0.5513	-0.0591	0.0487	0.0560	-0.0437	0.0599	-0.3365	-0.0887	-0.0131	-0.0424	-0.0283	-0.0341	0.0618	0.0151	-0.0378
-0.2287	0.1204	0.0160	-0.1714	-0.0460	-0.0591	0.2287	-0.0911	0.0360	0.0478	0.0493	0.0968	0.0182	0.0606	-0.0176	-0.0179	0.1087	-0.0021	0.0001	-0.0090
0.2362	-0.0726	0.1325	0.1899	0.0802	0.0457	-0.0911	0.3552	-0.0807	-0.1145	0.1552	-0.0593	-0.0567	-0.0353	0.0173	0.0733	-0.0777	-0.0112	-0.0836	0.0955
0.0511	0.1214	-0.1055	-0.0599	0.0501	0.0560	0.0360	-0.0807	0.3097	0.0623	-0.0539	-0.0622	0.0370	0.0600	-0.0562	0.0105	0.0411	-0.0250	0.0568	-0.0988
-0.1273	0.0986	-0.1423	-0.1654	-0.0371	-0.0437	0.0478	-0.1145	0.0623	0.2060	-0.1230	0.0780	0.0818	0.0209	-0.0203	-0.0826	0.0590	-0.0854	0.0384	-0.0494
0.1932	-0.0620	0.1089	0.1176	-0.0034	0.0599	-0.0493	0.1552	-0.0539	-0.1230	0.2357	-0.0920	-0.0692	-0.0299	-0.0105	0.0733	-0.0752	0.0677	-0.0103	0.0683
-0.1293	0.0805	-0.2075	-0.2235	0.0479	-0.3365	0.5968	-0.0593	-0.0622	0.0780	-0.0920	0.3574	0.1234	0.0279	0.0227	-0.0208	0.0169	-0.0937	-0.0162	-0.0165
0.0377	0.0260	-0.1655	-0.1013	0.0504	-0.0887	0.0182	-0.0567	0.0370	0.0818	-0.0692	0.1234	0.2013	0.0183	0.0327	-0.0593	-0.0106	0.1001	0.0445	-0.0992
-0.0496	0.0901	-0.0158	-0.0832	-0.0502	-0.0131	0.0600	-0.0353	0.0600	0.0209	-0.0298	0.0279	0.0183	0.1397	0.0044	-0.0271	0.0697	-0.0261	0.0098	-0.0103
0.0219	-0.0516	-0.0145	0.0296	-0.0383	-0.0424	-0.0176	0.0173	-0.0562	-0.0203	-0.0105	0.0227	0.0327	0.0044	0.1175	-0.0210	-0.0210	0.2339	-0.0154	0.0063
0.1026	-0.0118	-0.0313	0.0661	0.0593	-0.0283	-0.0179	0.0733	0.0105	-0.0826	0.0733	-0.0209	-0.0593	-0.0271	-0.0210	0.2339	-0.0154	0.0006	0.0503	0.0643
-0.1657	0.1516	0.0476	-0.1194	-0.0488	-0.0341	0.1087	-0.0777	0.0411	0.0590	-0.0752	0.0169	-0.0169	0.0697	-0.0313	-0.0154	0.2298	-0.0564	0.0063	0.0003
-0.0201	-0.0961	0.0795	0.1194	0.0091	0.0618	-0.0021	0.0112	-0.0250	-0.0854	0.0677	-0.0937	-0.1001	-0.0261	0.0032	0.0006	-0.0564	0.2001	-0.0155	0.0200
0.0147	0.0349	-0.1271	-0.0685	-0.0423	0.0151	0.0001	-0.0836	0.0568	0.0384	-0.0103	-0.0162	0.0445	0.0098	-0.0119	0.0503	0.0063	-0.0155	0.1882	-0.0404
0.0046	-0.0087	0.0830	0.0280	0.0267	-0.0378	-0.0090	0.0955	-0.0988	-0.0494	0.0683	-0.0165	-0.0992	-0.0103	0.0148	0.0643	0.0003	0.0200	-0.0404	0.1525

Class 8: Mean:

Covariance:

-1.4079	-0.4168	0.3629	1.5023	-2.5401	-0.4293	0.8854	-0.6107	-0.7975	-0.2394	0.3574	0.2818	0.3842	-0.0098	0.2754	0.1635	0.2964	0.3119	-0.0133	0.0515
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0.5463	-0.0483	0.1357	-0.0422	0.2288	0.0864	0.0597	0.0243	0.0588	-0.0803	-0.1096	-0.0126	0.0078	0.0226	0.0015	-0.0024	0.0100	0.0070	0.0231	-0.0249
-0.0483	0.3454	-0.0119	-0.0032	0.0007	-0.0359	0.0661	-0.1280	-0.0085	0.0170	0.0446	-0.0366	-0.0175	0.0517	-0.0240	0.0995	-0.0157	-0.0245	-0.0419	-0.0105
0.1357	-0.0119	0.9878	0.3482	0.1497	-0.0711	-0.0910	-0.0865	0.0736	-0.0474	0.0888	0.0443	0.1126	-0.1035	-0.0119	-0.2467	-0.0967	-0.0367	0.1305	0.0131
-0.0422	-0.0032	0.3482	0.4766	-0.1074	-0.0486	-0.0114	-0.1000	0.0392	-0.1605	-0.0095	0.0048	0.0774	-0.0727	0.0214	-0.1308	0.0046	-0.0504	0.0469	0.0296
0.2288	0.0007	0.1497	-0.1074	0.3813	0.9338	-0.0937	0.0637	-0.0191	0.0309	0.0564	0.0295	-0.0408	0.0165	-0.0594	-0.0575	0.0000	-0.0257	0.0451	0.0101
0.0864	-0.0359	-0.0711	-0.0486	0.0330	0.2565	0.0693	0.0557	0.0281	-0.0585	-0.0817	0.0089	-0.0148	0.0351	0.0145	0.0384	0.0163	0.0274	0.0063	-0.0326
0.0597	0.0661	-0.0910	-0.0114	-0.0937	0.0693	0.3197	-0.0254	-0.0450	-0.0110	-0.0277	-0.0119	-0.0227	0.0597	0.0315	0.1076	0.0327	0.0334	-0.0269	-0.0269
0.0243	-0.1280	-0.0865	-0.1000	0.0637	0.0557	-0.0254	0.2312	-0.0407	0.0032	0.0067	0.0477	-0.0239	-0.0198	-0.0117	-0.0106	0.0053	0.0236	0.0283	-0.0298
0.0588	-0.0085	0.0736	0.0392	-0.0191	0.0281	-0.0450	-0.0407	0.3668	-0.0419	-0.0207	0.0204	0.0639	0.0060	0.0414	-0.0116	0.0093	0.0181	-0.0070	0.0263
-0.0803	0.0170	-0.0474	-0.1605	0.0309	-0.0585	-0.0110	0.0002	-0.0419	0.2797	0.0481	0.0031	-0.0273	-0.0050	-0.0304	-0.0031	-0.0385	0.0217	-0.0166	0.0184
-0.1096	0.0446	0.0888	-0.0095	0.0564	-0.0817	-0.0277	0.0067	-0.0207	0.0481	0.2809	0.0168	-0.0136	0.0050	-0.0384	-0.0358	-0.0118	-0.0007	0.0108	0.0297
-0.0126	-0.0366	0.0443	0.0048	0.0295	0.0009	-0.0119	0.0477	0.0204	0.0031	0.0168	0.2258	-0.0046	0.0455	0.0151	-0.0418	-0.0004	0.0087	0.0208	0.0014
0.0078	-0.0175	0.1126	0.0774	-0.0404	-0.0148	-0.0227	-0.0239	0.0639	-0.0273	-0.0136	-0.0046	0.1803	-0.0125	0.0175	-0.0026	-0.0082	-0.0087	0.0132	-0.0017
0.0226	0.0517	-0.1035	-0.0727	0.0165	0.0351	0.0597	-0.0194	0.0660	-0.0050	0.0050	-0.0455	-0.0125	0.1970	-0.0169	0.0953	0.0321	0.0201	-0.0091	-0.0117
0.0015	-0.0240	-0.0119	0.0214	-0.0594	0.0145	0.0315	-0.0117	0.0414	-0.0304	0.0151	0.0175	-0.0169	0.1158	0.0177	-0.0074	0.0130	-0.0103	-0.0016	-0.0016
-0.0024	0.0995	-0.2467	-0.1308	-0.0575	0.0384	0.1076	-0.0106	-0.0116	-0.0031	-0.0358	-0.0418	-0.0026	0.0953	0.0177	0.2858	0.0334	0.0038	-0.0520	-0.0137
0.0100	-0.0157	-0.0967	0.0046	0.0000	0.0163	0.0327	0.0053	0.0099	-0.0385	-0.0118	-0.0004	-0.0062	0.0321	-0.0074	0.0334	0.1364	0.0040	-0.0094	-0.0168
0.0070	-0.0245	-0.0397	-0.0504	-0.0257	0.0274	0.0334	0.0236	0.0181	0.0217	-0.0007	0.0087	0.0201	0.0130	0.0038	0.0040	0.1608	0.0192	-0.0068	-0.0068
0.0231	-0.0419	0.1305	0.0469	0.0451	0.0063	-0.0269	0.0283	-0.0070	-0.0166	0.0108	0.0208	0.0132	-0.0091	-0.0103	-0.0520	-0.0094	0.0192	0.1344	0.0136
-0.0249	-0.0105	0.0131	0.0296	0.0101	-0.0326	-0.0269	0.0263	0.0184	0.0297	0.0014	-0.0017	-0.0117	-0.0016	-0.0137	-0.0168	-0.0068	0.0136	0.1386	-0.0040

Class 9: Mean:

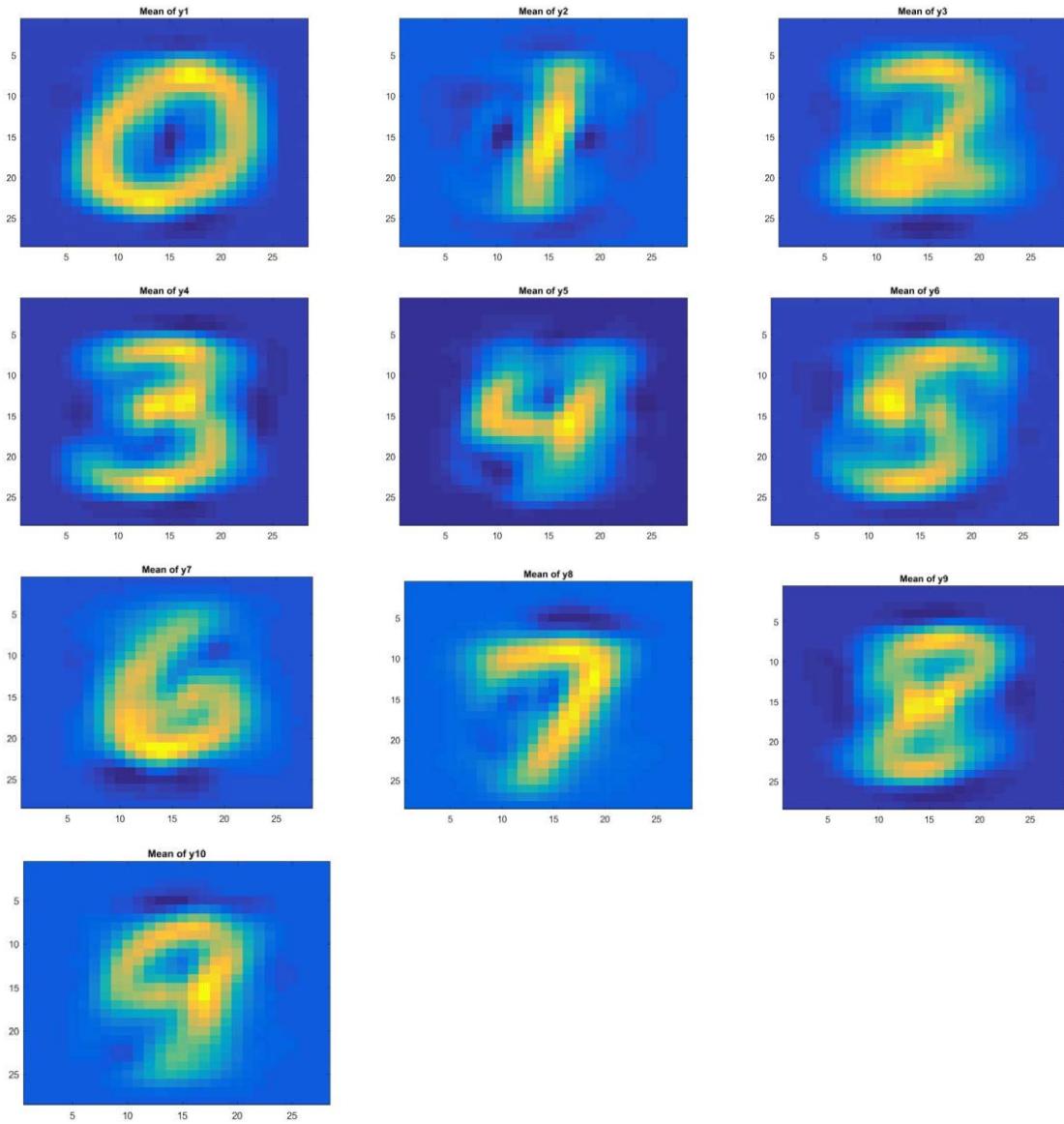
Covariance:

-1.2492	1.1455	0.1375	1.2521	-2.1345	-0.1147	0.9161	-0.2908	-0.9832	-0.2709	0.1582	0.3368	-0.2252	0.2189	0.1831	-0.0854	0.2586	0.3768	-0.0547	-0.1667	
0.5397	-0.1968	0.0640	0.1990	0.0862	0.1319	0.0140	-0.0815	0.0825	0.1693	-0.1813	0.1146	-0.0553	-0.0888	-0.2383	-0.0038	-0.0442	-0.0454	0.0335	0.0334	
-0.1968	0.3499	0.0185	-0.0158	-0.0995	-0.0163	-0.0274	0.0133	-0.0274	-0.1387	0.0372	0.0318	-0.0162	-0.0349	0.1611	-0.0104	-0.0289	0.0412	0.0161	-0.0600	
0.0640	0.0185	0.6715	0.2857	0.0553	-0.0986	0.0823	-0.1565	0.0496	0.3278	0.0890	0.0044	-0.0927	-0.1183	0.0714	0.0579	-0.0121	0.0162	0.0715	0.0187	
0.1990	-0.0158	0.2857	0.6146	-0.1121	0.2977	-0.0189	-0.0254	0.0307	0.0626	0.0599	0.0348	-0.0426	0.0225	0.0169	-0.0229	-0.0385	-0.0363	0.0081	0.0560	
0.0862	-0.0995	0.0553	-0.1121	0.2977	-0.0189	-0.0254	0.0307	0.0626	0.0599	0.0348	-0.0426	0.0225	0.0169	-0.0229	-0.0385	-0.0363	0.0081	0.0560	-0.0027	
0.1319	-0.0183	-0.0986	0.1390	-0.0189	0.2842	-0.0165	0.0086	-0.0163	-0.0173	-0.1314	0.1024	0.0092	-0.0652	-0.0783	0.0160	0.0272	-0.0267	0.0004	0.0323	
0.0140	-0.0274	0.0823	0.1490	-0.0254	-0.0164	0.2150	-0.0226	0.0068	0.0837	0.0189	0.0540	-0.0135	-0.0125	0.0021	-0.0038	0.0271	-0.0350	-0.0181	0.0705	
-0.0815	0.0133	-0.1565	-0.1156	0.0307	0.0086	-0.0226	0.0068	0.0206	-0.0654	0.0534	0.0207	-0.0471	0.0669	0.0097	0.0195	-0.0215	-0.0053	0.0064	-0.0228	
0.0825	-0.0274	0.0446	0.0446	0.0462	-0.0163	0.0063	-0.0046	-0.0554	0.3070	0.0218	-0.0147	0.0291	-0.0556	-0.0258	-0.0131	0.0161	-0.0235	-0.0443	-0.0517	0.0769
0.1693	-0.1387	0.3278	0.2550	0.0599	-0.0713	0.0837	-0.0534	0.0218	0.4077	0.0723	0.0373	-0.0407	0.0116	-0.0598	0.0123	-0.0911	-0.0213	0.0067	-0.0043	
-0.1813	0.0372	0.0890	-0.0871	0.0346	-0.1314	0.0189	0.0207	-0.0147	0.0723	0.2540	-0.0528	0.0033	0.0487	0.1085	-0.0025	-0.0558	-0.0021	0.0293	-0.0027	
0.1146	0.0318	0.0044	0.2349	-0.0426	0.1024	0.0540	-0.0471	0.0291	0.0373	-0.0528	0.2668	-0.0167	-0.0618	-0.0019	-0.0031	-0.0485	-0.0279	-0.0325	0.0490	
-0.0553	-0.0162	-0.0927	-0.0448	0.0225	0.0092	-0.0135	0.0669	-0.0556	-0.0407	0.0033	0.0167	0.1331	0.0446	-0.0169	-0.0026	0.0178	0.0118	-0.0455	-0.0160	
-0.0888	-0.0349	-0.1183	-0.0807	-0.0169	-0.0662	-0.0125	0.0097	-0.0258	0.0116	0.0487	-0.0618	0.0446	0.2027	-0.0126	0.0283	-0.0266	-0.0050	-0.0585	-0.0341	
-0.2383	0.1611	0.0714	-0.0459	-0.0278	-0.0783	0.0021	0.0195	-0.0131	-0.0598	0.1085	-0.0019	-0.0169	-0.0126	0.2339	-0.0097	0.0054	0.0104	0.0169	-0.0142	
-0.0038	-0.0104	0.0579	0.0710	-0.0229	0.0168	-0.0038	-0.0215	0.0161	0.0123	-0.0025	-0.0031	-0.0026	0.0283	-0.0097	0.1421	0.0294	-0.0090	0.0091	-0.0038	
-0.0442	-0.0289	-0.0121	-0.0531	-0.0385	0.0272	0.0271	-0.0053	-0.0238	-0.0911	-0.0558	-0.0485	0.0178	-0.0266	0.0054	0.0294	0.1575	0.0175	0.0097	0.0337	
-0.0454	0.0412	0.0162	-0.0274	-0.0363	-0.0267	-0.0350	0.0064	-0.0443	-0.0213	-0.0021	-0.0279	0.0118	-0.0050	0.0104	0.0104	0.0914	0.0068	-0.0301	-0.0301	
0.0335	0.0161	0.0715	-0.0495	0.0081	0.0004	-0.0181	-0.0228	-0.0517	0.0067	0.0293	-0.0325	-0.0455	0.0585	0.0169	-0.0091	0.0097	0.0068	0.1408	-0.0040	
0.0334	-0.0600	0.0187	0.0308	0.0560	0.0323	0.0705	-0.0117	0.0769	-0.0043	-0.0027	0.0480	-0.0160	-0.0341	-0.0142	-0.0038	0.0337	-0.0301	-0.0040	0.1367	

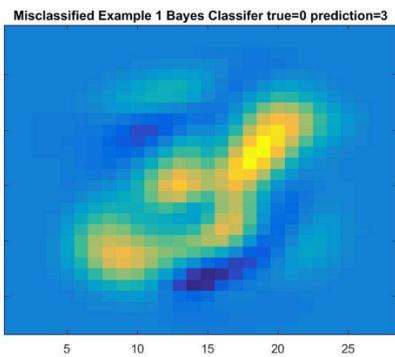
Confusion matrix:

48	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	49	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	48	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	1	47	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
0	0	0	0	0	48	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0	1	0	0	45	2	0	0	0	0	1	0	0	0	1	0	0	0
0	0	0	2	0	0	5	43	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	47	1	0
1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	47

Accuracy: 0.9360

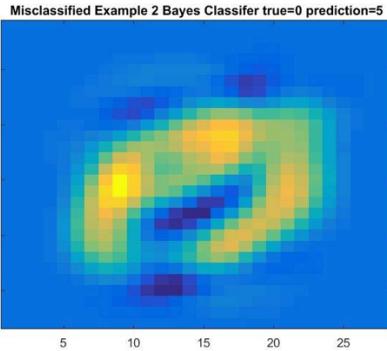


Misclassified Example 1:



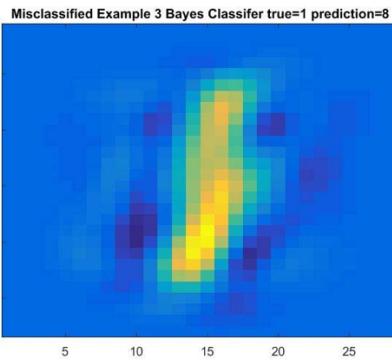
0	1	2	3	4	5	6	7	8	9
1.3863e-11	6.9148e-34	2.0580e-09	1.0650e-07	1.3924e-13	1.2823e-11	2.4642e-11	4.6092e-17	8.6651e-09	1.2052e-15

Misclassified Example 2:



0	1	2	3	4	5	6	7	8	9
7.0919e-30	0	5.5833e-30	2.4374e-37	1.5998e-41	2.9818e-25	4.6168e-32	2.3183e-71	1.5230e-26	2.5790e-45

Misclassified Example 3:



0	1	2	3	4	5	6	7	8	9
1.6808e-37	1.9866e-11	1.9243e-11	1.6392e-15	1.4470e-10	2.5358e-20	2.5959e-17	5.7591e-16	8.5818e-07	4.4238e-19

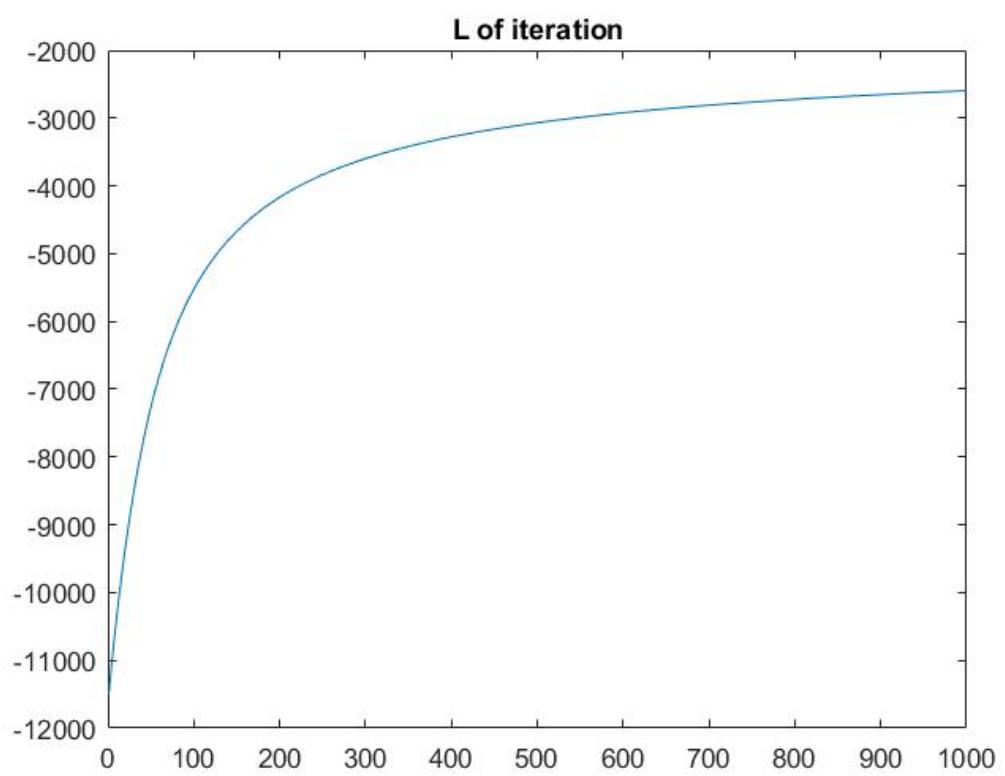
```

0.8716  0.0954  0.0079 -0.0834 -0.1052  0.1903 -0.2379  0.2799  0.0976  0.1273  0.0570 -0.1659  0.0025 -0.1637 -0.0206  0.0275 -0.0611 -0.1121 -0.0828  0.0607
0.0954  0.2422  0.1442 -0.0169 -0.1141  0.0798  0.0539  0.0907 -0.1041  0.0119 -0.0552 -0.0896  0.0348  0.0002  0.0313 -0.0315  0.0394 -0.0578 -0.0874 -0.0035
0.0079  0.1442  1.1558  0.4324 -0.0955  0.5159 -0.1991  0.4751 -0.2612 -0.0717  0.0348  0.0666 -0.0556  0.2997 -0.0821 -0.0290  0.1794 -0.0633  0.0058  0.0792
-0.0834 -0.0169  0.4324  0.6269 -0.0895  0.3041 -0.3624  0.1855 -0.0515 -0.0105  0.0601 -0.1039 -0.0954  0.1158  0.0005 -0.0816  0.1949  0.0143  0.0847  0.0237
-0.1052 -0.1141 -0.0955 -0.0895  0.4475 -0.3017 -0.0491 -0.2522 -0.0690 -0.2054  0.0887  0.2660  0.0367  0.2161 -0.2770 -0.0066 -0.0122  0.0912  0.1587 -0.0028
0.1903  0.0798  0.5159  0.3041 -0.3017  0.6725 -0.2445  0.2799  0.0259  0.1261 -0.1229 -0.1993 -0.0706  0.0199  0.1452 -0.0442  0.1294 -0.1098  0.0217  0.0229
-0.2379  0.0539 -0.1991 -0.2624 -0.0491 -0.2443  0.4570 -0.0939 -0.1547 -0.0753 -0.0624  0.0574  0.0900 -0.0708 -0.0187  0.0147 -0.1543  0.0264 -0.0703 -0.0796
0.2759  0.0907  0.4751  0.1855 -0.2522  0.2759 -0.0939  0.5675 -0.0910  0.0831  0.0664 -0.0616 -0.0013 -0.0006  0.0784 -0.0070  0.0356 -0.0685 -0.0623  0.0298
0.0976 -0.1041 -0.2612 -0.0515 -0.0690  0.0259 -0.1547 -0.0910  0.4921  0.0889 -0.0511 -0.0708 -0.0675 -0.0123  0.1560  0.0114 -0.0701  0.0225 -0.0010 -0.0050
0.1273  0.0119 -0.0717 -0.0105 -0.2054  0.1261 -0.0753  0.0831  0.0689  0.2044 -0.0442 -0.1236 -0.0583 -0.1677  0.1368  0.0264  0.0422 -0.0407 -0.0559 -0.0077
0.0570 -0.0582  0.0346  0.0601  0.0887 -0.1229 -0.0624  0.0664 -0.0511 -0.0442  0.2663  0.0430  0.0192  0.0058 -0.0992  0.0283 -0.0071  0.0089  0.0035  0.0873
-0.1659 -0.0895  0.0666 -0.1039  0.2660 -0.1993  0.0574 -0.0616 -0.0708 -0.1236  0.0430  0.3059  0.0580  0.1993 -0.1598  0.0512 -0.0286  0.0578  0.0742  0.0102
0.0025  0.0348 -0.0056 -0.0954  0.0367 -0.0706  0.0900 -0.0013 -0.0675 -0.0583  0.0192  0.0580  0.1384  0.0434 -0.0313  0.0102 -0.0546  0.0014  0.0218  0.0065
-0.1637  0.0002  0.2997  0.1158  0.2161  0.0199 -0.0708 -0.0006 -0.0123 -0.1677  0.0058  0.1893  0.0434  0.4020 -0.1015 -0.0395  0.0753  0.0370  0.1156  0.0336
-0.0205  0.0313 -0.0921  0.0205 -0.2770  0.1452 -0.0187  0.0784  0.1550  0.1368 -0.0992 -0.1598 -0.0313 -0.1015  0.3121 -0.0213  0.0126 -0.0412 -0.0470 -0.0251
0.0275 -0.0315 -0.0290 -0.0816 -0.0066 -0.0442  0.0147 -0.0070  0.0114  0.0264  0.0283  0.0512  0.0102 -0.0395 -0.0213  0.1340 -0.0460 -0.0113 -0.0324  0.0309
-0.0611  0.0394  0.1794  0.1949 -0.0122  0.1294 -0.1543  0.0356 -0.0701  0.0422 -0.0071 -0.0286 -0.0546  0.0753  0.0126 -0.0460  0.2547 -0.0281  0.0133  0.0044
-0.1121 -0.0578 -0.0633  0.0143  0.0912 -0.1098  0.0284 -0.0685  0.0225 -0.0407  0.0089  0.0578  0.0014  0.0570 -0.0412 -0.0113 -0.0281  0.1840  0.0327  0.0007
-0.0828 -0.0874  0.0058  0.0847  0.1587  0.0217 -0.0703 -0.0623 -0.0010 -0.0559  0.0035  0.0742  0.0218  0.1156 -0.0470 -0.0324  0.0133  0.0327  0.2131  0.0001
0.0607 -0.0035  0.0792  0.0237 -0.0028  0.0229 -0.0796  0.0298 -0.0059 -0.0077  0.0873  0.0102  0.0065  0.0336 -0.0251  0.0309  0.0044  0.0007  0.0001  0.1178

```

(c)

L of iteration:

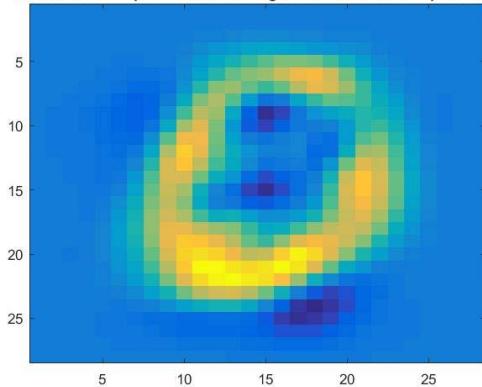


Confusion matrix:

46	0	1	1	0	0	2	0	0	0
0	49	0	0	0	0	0	0	1	0
0	0	38	2	1	0	4	0	5	0
1	0	2	39	0	2	0	1	5	0
0	0	1	0	42	1	0	0	1	5
1	1	0	4	2	39	1	0	0	2
0	0	1	0	4	3	42	0	0	0
0	0	3	0	1	0	0	44	1	1
0	0	0	0	0	2	1	0	46	1
0	1	1	0	3	0	0	1	0	44

Accuracy: 0.8580 Misclassified Example 1:

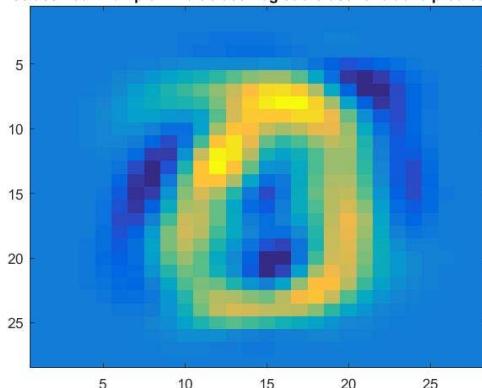
Misclassified Example 1 Multiclass Logistic Classifier true=0 prediction=6



0	1	2	3	4	5	6	7	8	9
0.3941	5.8751e-06	0.0300	8.4074e-05	6.0234e-04	0.0091	0.5649	3.1581e-05	0.0011	3.0921e-05

Misclassified Example 2:

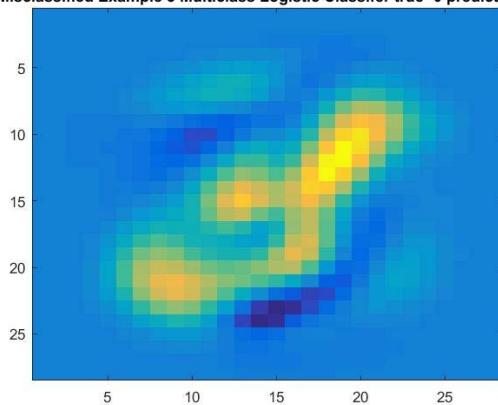
Misclassified Example 2 Multiclass Logistic Classifier true=0 prediction=3



0	1	2	3	4	5	6	7	8	9
0.2657	6.3372e-04	0.0397	0.2775	0.0044	0.1847	0.0103	0.0237	0.1197	0.0737

Misclassified Example 3:

Misclassified Example 3 Multiclass Logistic Classifier true=0 prediction=2



0	1	2	3	4	5	6	7	8	9
0.0196	0.0370	0.3271	0.1365	0.2221	0.0440	0.0182	0.0297	0.1154	0.0504