Fall 2019

Computer Vision Programming Documentation

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Making use of the CIFAR-10dataset, I implemented the following two training and classification methods and analyzed their respective performance.

Fisher LDF:

Trained and tested a 10-class Fisher Linear Discriminant Function classifier using the Mahalanobis distance as the metric for classification. The Following confusion matrix is obtained.

	0	1	2	3	4	5	6	7	8	9		
0	103	103	13	9	10	9	9	18	15	0	36%	64%
1	89	89	11	15	9	7	12	10	9	0	35%	65%
2	100	100	8	14	8	9	14	15	6	0	3%	97%
3	103	103	10	15	13	7	11	17	11	0	5%	95%
4	90	90	7	7	11	11	8	8	9	0	5%	95%
5	86	86	11	15	9	9	6	11	12	0	4%	96%
6	112	112	19	11	17	9	14	17	8	0	4%	96%
7	102	102	9	16	9	9	7	18	12	0	6%	94%
8	106	106	11	21	13	7	9	15	7	0	2%	98%
9	109	109	13	12	12	4	20	10	13	0	0%	100%
											10%	90%

CNN:

1	Input Image	32 x 32 x 3 images with 'zerocenter' normalization
2	Convolution Layer	32 5 x 5 convolutions with stride = 1 and padding = 2
3	Activation Function	ReLU
4	Pooling	2 x 2 max pooling with stride = 2
5	Convolution Layer	32 5 x 5 convolutions with stride = 1
6	Activation Function	ReLU
7	Pooling	2 x 2 max pooling with stride = 2
8	Convolution Layer	64 5 x 5 convolutions with stride = 1
9	Activation Function	ReLU
10	Pooling	2 x 2 max pooling with stride = 2
11	Fully Connected Layer	64
12	Activation Function	ReLU
13	Fully Connected Layer	10
14	Activation Function	Softmax
15	Loss Function	Cross-Entropy

Based on the above configurations, I trained 50,000 images from the CIFAR-10 data using convolutional neural net, and then used 10,000 images for classification. For learning, iterations of 350, Epoch of 40, and learning rate of 0.001 were used. The Accuracy and the loss is tabulated in the following table.

Epoch	Iteration	Time Elapsed (hh:mm:ss)	Mini-batch Accuracy	Mini-batch Loss	Base Learning Rate
1	1	00:00:00	10.94%	2.3025	0.0010
1	50	00:00:01	16.41%	2.2940	0.0010
1	100	00:00:02	10.16%	2.2848	0.0010
1	150	00:00:03	10.94%	2.2460	0.0010
1	200	00:00:04	20.31%	2.1237	0.0010
1	250	00:00:05	17.19%	2.0913	0.0010
1	300	00:00:06	22.66%	2.0339	0.0010
1	350	00:00:07	17.19%	1.9505	0.0010
2	400	00:00:08	21.88%	1.8687	0.0010
2	450	00:00:09	30.47%	1.7555	0.0010
2	500	00:00:10	28.91%	1.7390	0.0010
2	550	00:00:11	29.69%	1.7215	0.0010
2	600	00:00:13	35.94%	1.6868	0.0010
2	650	00:00:14	42.19%	1.5993	0.0010
2	700	00:00:15	38.28%	1.5765	0.0010
2	750	00:00:16	43.75%	1.4983	0.0010
3	800	00:00:17	35.16%	1.4909	0.0010
3	850	00:00:18	35.16%	1.5596	0.0010
3	900	00:00:19	39.06%	1.4672	0.0010
3	950	00:00:20	32.03%	1.5171	0.0010
3	1000	00:00:21	47.66%	1.4160	0.0010
3	1050	00:00:22	44.53%	1.5271	0.0010
3	1100	00:00:23	39.84%	1.4237	0.0010
3	1150	00:00:24	42.19%	1.4409	0.0010
4	1200	00:00:25	43.75%	1.4114	0.0010
4	1250	00:00:26	46.88%	1.3946	0.0010
4	1300	00:00:27	53.13%	1.2928	0.0010
4	1350	00:00:29	56.25%	1.2388	0.0010
4	1400	00:00:30	53.91%	1.2586	0.0010
4	1450	00:00:31	55.47%	1.2970	0.0010
4	1500	00:00:32	58.59%	1.2123	0.0010
4	1550	00:00:33	56.25%	1.1571	0.0010
5	1600	00:00:34	60.94%	1.0789	0.0010
5	1650	00:00:35	58.59%	1.1619	0.0010
5	1700	00:00:36	66.41%	1.0267	0.0010
5	1750	00:00:37	64.06%	1.0755	0.0010
5	1800	00:00:38	62.50%	0.9970	0.0010
5	1850	00:00:39	64.06%	1.0490	0.0010

6	2000	00:00:42	60.94%	1.1345	0.0010
6	2050	00:00:43	65.63%	0.9144	0.0010
6	2100	00:00:44	65.63%	0.9387	0.0010
6	2150	00:00:45	61.72%	1.0698	0.0010
6	2200	00:00:46	68.75%	0.8474	0.0010
6	2250	00:00:48	58.59%	1.1443	0.0010
6	2300	00:00:49	54.69%	1.1916	0.0010
7	2350	00:00:50	65.63%	0.9753	0.0010
7	2400	00:00:51	76.56%	0.9070	0.0010
7	2450	00:00:52	67.19%	0.9599	0.0010
7	2500	00:00:53	68.75%	0.9444	0.0010
7	2550	00:00:54	60.94%	1.0633	0.0010
7	2600	00:00:55	67.19%	0.8333	0.0010
7	2650	00:00:56	70.31%	0.8247	0.0010
7	2700	00:00:57	71.09%	0.8298	0.0010
8	2750	00:00:58	72.66%	0.8936	0.0010
8	2800	00:00:59	70.31%	0.9502	0.0010
8	2850	00:01:00	67.97%	0.8163	0.0010
8	2900	00:01:01	66.41%	0.8409	0.0010
8	2950	00:01:02	70.31%	0.8086	0.0010
8	3000	00:01:03	64.06%	0.9976	0.0010
8	3050	00:01:04	68.75%	0.8805	0.0010
8	3100	00:01:05	68.75%	0.8732	0.0010
9	3150	00:01:06	60.94%	0.9028	0.0001
9	3200	00:01:08	69.53%	0.8587	0.0001
9	3250	00:01:09	69.53%	0.8191	0.0001
9	3300	00:01:10	73.44%	0.7759	0.0001
9	3350	00:01:11	71.88%	0.8172	0.0001
9	3400	00:01:12	76.56%	0.7742	0.0001
9	3450	00:01:13	75.00%	0.8383	0.0001
9	3500	00:01:14	71.88%	0.7450	0.0001
10	3550	00:01:15	72.66%	0.7491	0.0001
10	3600	00:01:16	70.31%	0.8554	0.0001
10	3650	00:01:17	76.56%	0.7532	0.0001
10	3700	00:01:18	73.44%	0.7445	0.0001
10	3750	00:01:19	77.34%	0.6746	0.0001
10	3800	00:01:20	77.34%	0.6480	0.0001
10	3850	00:01:21	75.78%	0.7187	0.0001
10	3900	00:01:22	75.00%	0.6718	0.0001
11	3950	00:01:23	67.19%	0.8770	0.0001
11	4000	00:01:24	77.34%	0.6389	0.0001
11	4050	00:01:25	78.91%	0.7194	0.0001
11	4100	00:01:26	67.97%	0.8345	0.0001

11	4250	00:01:30	68.75%	0.8990	0.0001
12	4300	00:01:31	75.00%	0.7785	0.0001
12	4350	00:01:32	78.91%	0.7173	0.0001
12	4400	00:01:33	71.88%	0.7590	0.0001
12	4450	00:01:34	77.34%	0.7711	0.0001
12	4500	00:01:35	67.97%	0.8783	0.0001
12	4550	00:01:36	75.00%	0.7000	0.0001
12	4600	00:01:37	80.47%	0.6116	0.0001
12	4650	00:01:38	79.69%	0.6985	0.0001
13	4700	00:01:39	78.91%	0.7450	0.0001
13	4750	00:01:40	69.53%	0.8463	0.0001
13	4800	00:01:41	75.00%	0.7071	0.0001
13	4850	00:01:42	71.09%	0.7329	0.0001
13	4900	00:01:43	75.78%	0.6697	0.0001
13	4950	00:01:44	68.75%	0.8887	0.0001
13	5000	00:01:45	75.78%	0.7133	0.0001
13	5050	00:01:46	76.56%	0.7622	0.0001
14	5100	00:01:47	71.88%	0.8135	0.0001
14	5150	00:01:48	73.44%	0.8041	0.0001
14	5200	00:01:49	75.78%	0.7304	0.0001
14	5250	00:01:51	73.44%	0.7266	0.0001
14	5300	00:01:52	72.66%	0.7763	0.0001
14	5350	00:01:53	75.78%	0.7150	0.0001
14	5400	00:01:54	77.34%	0.7994	0.0001
14	5450	00:01:55	71.88%	0.7224	0.0001
15	5500	00:01:56	73.44%	0.7086	0.0001
15	5550	00:01:57	71.88%	0.8137	0.0001
15	5600	00:01:58	75.00%	0.7131	0.0001
15	5650	00:01:59	77.34%	0.7029	0.0001
15	5700	00:02:00	78.91%	0.6314	0.0001
15	5750	00:02:01	79.69%	0.6144	0.0001
15	5800	00:02:02	76.56%	0.6813	0.0001
15	5850	00:02:03	78.13%	0.6495	0.0001
16	5900	00:02:04	68.75%	0.8430	0.0001
16	5950	00:02:05	78.13%	0.6116	0.0001
16	6000	00:02:06	75.78%	0.7009	0.0001
16	6050	00:02:07	69.53%	0.8029	0.0001
16	6100	00:02:08	78.91%	0.6148	0.0001
16	6150	00:02:09	75.00%	0.7386	0.0001
16	6200	00:02:11	71.09%	0.8711	0.0001
17	6250	00:02:12	73.44%	0.7452	1.0000e-05
17	6300	00:02:13	81.25%	0.6790	1.0000e-05
17	6350	00:02:14	76.56%	0.7276	1.0000e-05

17	6500	00:02:17	75.78%	0.6475	1.0000e-05
17	6550	00:02:18	81.25%	0.5716	1.0000e-05
17	6600	00:02:19	79.69%	0.6536	1.0000e-05
18	6650	00:02:20	82.03%	0.6981	1.0000e-05
18	6700	00:02:21	71.09%	0.8235	1.0000e-05
18	6750	00:02:22	75.78%	0.6625	1.0000e-05
18	6800	00:02:23	75.78%	0.6923	1.0000e-05
18	6850	00:02:24	78.13%	0.6167	1.0000e-05
18	6900	00:02:25	68.75%	0.8415	1.0000e-05
18	6950	00:02:26	78.13%	0.6850	1.0000e-05
18	7000	00:02:27	81.25%	0.7087	1.0000e-05
19	7050	00:02:28	71.88%	0.7833	1.0000e-05
19	7100	00:02:29	71.88%	0.7874	1.0000e-05
19	7150	00:02:30	78.91%	0.6961	1.0000e-05
19	7200	00:02:31	73.44%	0.6959	1.0000e-05
19	7250	00:02:33	75.00%	0.7508	1.0000e-05
19	7300	00:02:34	75.78%	0.6688	1.0000e-05
19	7350	00:02:35	76.56%	0.7814	1.0000e-05
19	7400	00:02:36	73.44%	0.6916	1.0000e-05
20	7450	00:02:37	76.56%	0.6702	1.0000e-05
20	7500	00:02:38	75.78%	0.7833	1.0000e-05
20	7550	00:02:39	77.34%	0.6968	1.0000e-05
20	7600	00:02:40	77.34%	0.6630	1.0000e-05
20	7650	00:02:41	78.13%	0.6005	1.0000e-05
20	7700	00:02:42	78.13%	0.5995	1.0000e-05
20	7750	00:02:43	76.56%	0.6557	1.0000e-05
20	7800	00:02:44	78.91%	0.6184	1.0000e-05
21	7850	00:02:45	69.53%	0.8159	1.0000e-05
21	7900	00:02:46	81.25%	0.6003	1.0000e-05
21	7950	00:02:47	79.69%	0.6789	1.0000e-05
21	8000	00:02:48	68.75%	0.7895	1.0000e-05
21	8050	00:02:49	79.69%	0.5937	1.0000e-05
21	8100	00:02:50	77.34%	0.7287	1.0000e-05
21	8150	00:02:51	69.53%	0.8634	1.0000e-05
22	8200	00:02:52	74.22%	0.7359	1.0000e-05
22	8250	00:02:54	82.03%	0.6628	1.0000e-05
22	8300	00:02:55	75.78%	0.7170	1.0000e-05
22	8350	00:02:56	76.56%	0.7317	1.0000e-05
22	8400	00:02:57	72.66%	0.7962	1.0000e-05
22	8450	00:02:58	75.78%	0.6435	1.0000e-05
22	8500	00:02:59	81.25%	0.5668	1.0000e-05
22	8550	00:03:00	80.47%	0.6512	1.0000e-05
23	8600	00:03:01	82.81%	0.6910	1.0000e-05

23	8750	00:03:04	75.78%	0.6882	1.0000e-05
23	8800	00:03:05	78.13%	0.6096	1.0000e-05
23	8850	00:03:06	67.97%	0.8379	1.0000e-05
23	8900	00:03:07	78.13%	0.6803	1.0000e-05
23	8950	00:03:08	80.47%	0.7068	1.0000e-05
24	9000	00:03:09	71.88%	0.7772	1.0000e-05
24	9050	00:03:10	71.88%	0.7845	1.0000e-05
24	9100	00:03:11	78.91%	0.6888	1.0000e-05
24	9150	00:03:12	72.66%	0.6908	1.0000e-05
24	9200	00:03:13	75.00%	0.7453	1.0000e-05
24	9250	00:03:14	76.56%	0.6651	1.0000e-05
24	9300	00:03:15	77.34%	0.7788	1.0000e-05
24	9350	00:03:17	73.44%	0.6908	1.0000e-05
25	9400	00:03:18	76.56%	0.6626	1.0000e-06
25	9450	00:03:19	75.00%	0.7827	1.0000e-06
25	9500	00:03:20	76.56%	0.6983	1.0000e-06
25	9550	00:03:21	77.34%	0.6554	1.0000e-06
25	9600	00:03:22	78.13%	0.5947	1.0000e-06
25	9650	00:03:23	79.69%	0.5949	1.0000e-06
25	9700	00:03:24	76.56%	0.6493	1.0000e-06
25	9750	00:03:25	78.91%	0.6134	1.0000e-06
26	9800	00:03:26	71.09%	0.8116	1.0000e-06
26	9850	00:03:27	81.25%	0.5941	1.0000e-06
26	9900	00:03:28	79.69%	0.6721	1.0000e-06
26	9950	00:03:29	70.31%	0.7829	1.0000e-06
26	10000	00:03:30	80.47%	0.5874	1.0000e-06
26	10050	00:03:31	77.34%	0.7244	1.0000e-06
26	10100	00:03:32	69.53%	0.8546	1.0000e-06
27	10150	00:03:33	74.22%	0.7359	1.0000e-06
27	10200	00:03:34	81.25%	0.6581	1.0000e-06
27	10250	00:03:35	78.13%	0.7110	1.0000e-06
27	10300	00:03:36	77.34%	0.7288	1.0000e-06
27	10350	00:03:38	71.88%	0.7884	1.0000e-06
27	10400	00:03:39	75.78%	0.6374	1.0000e-06
27	10450	00:03:40	81.25%	0.5660	1.0000e-06
27	10500	00:03:41	82.03%	0.6461	1.0000e-06
28	10550	00:03:42	82.81%	0.6884	1.0000e-06
28	10600	00:03:43	70.31%	0.8161	1.0000e-06
28	10650	00:03:44	76.56%	0.6525	1.0000e-06
28	10700	00:03:45	76.56%	0.6869	1.0000e-06
28	10750	00:03:46	78.13%	0.6076	1.0000e-06
28	10800	00:03:47	67.97%	0.8308	1.0000e-06
28	10850	00:03:48	77.34%	0.6799	1.0000e-06

29	11000	00:03:51	71.09%	0.7910	1.0000e-06
29	11050	00:03:52	79.69%	0.6869	1.0000e-06
29	11100	00:03:53	74.22%	0.6909	1.0000e-06
29	11150	00:03:54	75.78%	0.7432	1.0000e-06
29	11200	00:03:55	75.78%	0.6632	1.0000e-06
29	11250	00:03:56	76.56%	0.7753	1.0000e-06
29	11300	00:03:58	72.66%	0.6896	1.0000e-06
30	11350	00:03:59	77.34%	0.6627	1.0000e-06
30	11400	00:04:00	74.22%	0.7804	1.0000e-06
30	11450	00:04:01	77.34%	0.6948	1.0000e-06
30	11500	00:04:02	78.91%	0.6564	1.0000e-06
30	11550	00:04:03	78.13%	0.5948	1.0000e-06
30	11600	00:04:04	79.69%	0.5948	1.0000e-06
30	11650	00:04:05	76.56%	0.6491	1.0000e-06
30	11700	00:04:06	78.91%	0.6131	1.0000e-06
31	11750	00:04:07	71.09%	0.8110	1.0000e-06
31	11800	00:04:08	81.25%	0.5936	1.0000e-06
31	11850	00:04:09	79.69%	0.6726	1.0000e-06
31	11900	00:04:10	70.31%	0.7806	1.0000e-06
31	11950	00:04:11	80.47%	0.5874	1.0000e-06
31	12000	00:04:12	77.34%	0.7239	1.0000e-06
31	12050	00:04:13	69.53%	0.8540	1.0000e-06
32	12100	00:04:14	74.22%	0.7349	1.0000e-06
32	12150	00:04:16	81.25%	0.6572	1.0000e-06
32	12200	00:04:17	78.13%	0.7106	1.0000e-06
32	12250	00:04:18	77.34%	0.7283	1.0000e-06
32	12300	00:04:19	71.88%	0.7885	1.0000e-06
32	12350	00:04:20	75.78%	0.6375	1.0000e-06
32	12400	00:04:21	81.25%	0.5656	1.0000e-06
32	12450	00:04:22	81.25%	0.6464	1.0000e-06
33	12500	00:04:23	82.81%	0.6875	1.0000e-07
33	12550	00:04:24	70.31%	0.8154	1.0000e-07
33	12600	00:04:25	75.78%	0.6516	1.0000e-07
33	12650	00:04:26	76.56%	0.6863	1.0000e-07
33	12700	00:04:27	78.91%	0.6071	1.0000e-07
33	12750	00:04:29	67.97%	0.8305	1.0000e-07
33	12800	00:04:30	77.34%	0.6793	1.0000e-07
33	12850	00:04:31	81.25%	0.7017	1.0000e-07
34	12900	00:04:32	71.88%	0.7763	1.0000e-07
34	12950	00:04:33	71.09%	0.7911	1.0000e-07
34	13000	00:04:34	79.69%	0.6855	1.0000e-07
34	13050	00:04:35	74.22%	0.6907	1.0000e-07
34	13100	00:04:36	75.78%	0.7424	1.0000e-07

35	13550	00:04:46	79.69%	0.5948	1.0000e-07
35	13600	00:04:47	76.56%	0.6488	1.0000e-07
35	13650	00:04:48	78.91%	0.6129	1.0000e-07
36	13700	00:04:49	71.09%	0.8105	1.0000e-07
36	13750	00:04:50	81.25%	0.5930	1.0000e-07
36	13800	00:04:51	79.69%	0.6723	1.0000e-07
36	13850	00:04:52	70.31%	0.7801	1.0000e-07
36	13900	00:04:53	80.47%	0.5866	1.0000e-07
36	13950	00:04:54	77.34%	0.7232	1.0000e-07
36	14000	00:04:55	69.53%	0.8536	1.0000e-07
37	14050	00:04:56	74.22%	0.7349	1.0000e-07
37	14100	00:04:57	81.25%	0.6567	1.0000e-07
37	14150	00:04:58	78.13%	0.7099	1.0000e-07
37	14200	00:04:59	78.13%	0.7277	1.0000e-07
37	14250	00:05:00	71.88%	0.7879	1.0000e-07
37	14300	00:05:01	75.78%	0.6376	1.0000e-07
37	14350	00:05:02	81.25%	0.5653	1.0000e-07
37	14400	00:05:03	82.03%	0.6459	1.0000e-07
38	14450	00:05:05	82.81%	0.6873	1.0000e-07
38	14500	00:05:06	70.31%	0.8152	1.0000e-07
38	14550	00:05:07	75.78%	0.6515	1.0000e-07
38	14600	00:05:08	76.56%	0.6862	1.0000e-07
38	14650	00:05:09	78.91%	0.6072	1.0000e-07
38	14700	00:05:10	67.97%	0.8304	1.0000e-07
38	14750	00:05:11	77.34%	0.6792	1.0000e-07
38	14800	00:05:12	81.25%	0.7016	1.0000e-07
39	14850	00:05:13	71.88%	0.7762	1.0000e-07
39	14900	00:05:14	71.09%	0.7909	1.0000e-07
39	14950	00:05:15	79.69%	0.6854	1.0000e-07
39	15000	00:05:16	74.22%	0.6907	1.0000e-07
39	15050	00:05:17	75.78%	0.7423	1.0000e-07
39	15100	00:05:18	76.56%	0.6626	1.0000e-07
39	15150	00:05:19	75.78%	0.7749	1.0000e-07
39	15200	00:05:20	72.66%	0.6892	1.0000e-07
40	15250	00:05:21	78.13%	0.6622	1.0000e-07
40	15300	00:05:22	74.22%	0.7801	1.0000e-07
40	15350	00:05:23	77.34%	0.6934	1.0000e-07
40	15400	00:05:24	78.91%	0.6558	1.0000e-07
40	15450	00:05:26	78.13%	0.5945	1.0000e-07
40	15500	00:05:27	79.69%	0.5947	1.0000e-07
40	15550	00:05:28	76.56%	0.6488	1.0000e-07
40	15600	00:05:29	78.91%	0.6129	1.0000e-07

Following the learning process, I run a test on the 10,000 images from the CIFAR-10 test batch. I have tabulated the confusion matrix as follows.

Confusion Matrix

Output Class \ Target Class	airplane	automobile	bird	cat	deer	dog	frog	horse	ship	truck	
airplane	**761** 7.6%	**23** 0.2%	**65** 0.7%	**22** 0.2%	**13** 0.1%	**1** 0.0%	**8** 0.1%	**8** 0.1%	**60** 0.6%	**39** 0.4%	76.1% 23.9%
automobile	**17** 0.2%	**840** 8.4%	**0** 0.0%	**8** 0.1%	**2** 0.0%	**3** 0.0%	**7** 0.1%	**4** 0.0%	**31** 0.3%	**88** 0.9%	84.0% 16.0%
bird	**68** 0.7%	**4** 0.0%	**593** 5.9%	**51** 0.5%	**106** 1.1%	**68** 0.7%	**60** 0.6%	**32** 0.3%	**13** 0.1%	**5** 0.1%	59.3% 40.7%
cat	**20** 0.2%	**7** 0.1%	**82** 0.8%	**473** 4.7%	**47** 0.5%	**222** 2.2%	**83** 0.8%	**38** 0.4%	**13** 0.1%	**15** 0.1%	47.3% 52.7%
deer	**33** 0.3%	**2** 0.0%	**100** 1.0%	**45** 0.4%	**657** 6.6%	**23** 0.2%	**64** 0.6%	**68** 0.7%	**6** 0.1%	**2** 0.0%	65.7% 34.3%
dog	**10** 0.1%	**2** 0.0%	**53** 0.5%	**193** 1.9%	**30** 0.3%	**625** 6.3%	**22** 0.2%	**63** 0.6%	**1** 0.0%	**1** 0.0%	62.5% 37.5%
frog	**4** 0.0%	**1** 0.0%	**41** 0.4%	**83** 0.8%	**43** 0.4%	**13** 0.1%	**803** 8.0%	**6** 0.1%	**4** 0.0%	**2** 0.0%	80.3% 19.7%
horse	**10** 0.1%	**4** 0.0%	**30** 0.3%	**32** 0.3%	**67** 0.7%	**65** 0.7%	**4** 0.0%	**778** 7.8%	**0** 0.0%	**10** 0.1%	77.8% 22.2%
ship	**71** 0.7%	**32** 0.3%	**12** 0.1%	**14** 0.1%	**1** 0.0%	**0** 0.0%	**2** 0.0%	**1** 0.0%	**834** 8.3%	**33** 0.3%	83.4% 16.6%
truck	**31** 0.3%	**70** 0.7%	**3** 0.0%	**14** 0.1%	**3** 0.0%	**1** 0.0%	**4** 0.0%	**18** 0.2%	**23** 0.2%	**833** 8.3%	83.3% 16.7%
	74.2% 25.8%	85.3% 14.7%	60.6% 39.4%	50.6% 49.4%	67.8% 32.2%	61.2% 38.8%	76.0% 24.0%	76.6% 23.4%	84.7% 15.3%	81.0% 19.0%	**72.0%** **28.0%**

Analysis:

From the above observations, we can conclude that the Fisher LDF algorithm falls short when compared with convolutional neural net.

References:

Lecture notes and slides