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Course: Advanced Image Processing

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Assignment 1 – Sift vs. Raw Image for MLP Classifiers

Summary: I attempted to classify a 99-class leaf dataset using two different inputs to neural networks; raw image and sift features. When I used SIFT, I had to use the bag of words technique to utilize this information in a useful manner, this leads to an average F1 score of 0.72. When I fed the raw image (normalized) to the neural network I got much worse results with all the classes included, those results are shown below. I then completed this second method by reducing the number of classes used to produce somewhat acceptable results achieving an average F1 score of 0.36. I later replaced the input images to both systems with images that were resized as SVG's then converted to jpeg as opposed to resizing jpegs with interpolation and this produced a more positive outcome especially for the raw image classifier which now had an average F1 score of 0.64.

Dataset Description: The leaf dataset consists of 990 black and white images. This is a multi-class dataset with 99 classes and 10 images per class. In spite of the poor dataset ratio (data/class) the results were acceptable.

Normalizing Images: Originally images were being fed to the Raw Image Classifier were resized to be 300 x 300 using the interpolation technique from the resize method of the cv2 library. Later images were being resized by converting the jpeg to SVG and then resizing to 300x300, and then converting back to jpeg. There was no need to grayscale this dataset because it was already black and white. One thing to note is that I did not divide my images by 255 because it messed up my loss curve and reduced accuracy.

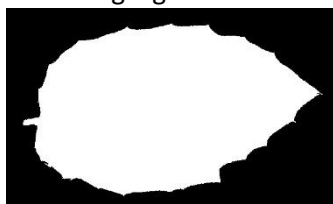
Splitting the dataset: I split the dataset into the test and train datasets using a 70:30 split.

Compare sift classifier and raw image classifier: The sift classifier performed way better than the raw image classifier in every case. Raw images that are not resized had horrific results, especially when all 99 classes were used – the results improved significantly when only 15 classes were used.

SVG resizing also had a positive effect on performance. For the raw image classifier the effect was massive while for the sift classifier the effect was smaller but in both cases the results were consistently positive. The alternative to SVG resizing that I originally used was interpolation resizing (from the open cv2 library).

Here is an example of what I cannot classify well and my explanation of why:

Through all of my non-sift trials I was never able to classify class 4 successfully, it was shocking to see such a low mark so consistently. I went to see why this was the case, and for the following image shown below. It became pretty clear why I struggled with this class in particular, it lacked many unique boundaries and was very similar to other classes such as class 6 – especially after resizing the image into 300x300 square making the overall shape of the leaf less relevant but making the boundary far more relevant. I suspect the best way to solve this problem is to zoom in on the desired size (effectively cropping the image to the correct size) thereby preserving the general of the leaf but probably sacrificing a good chunk of the leaf.



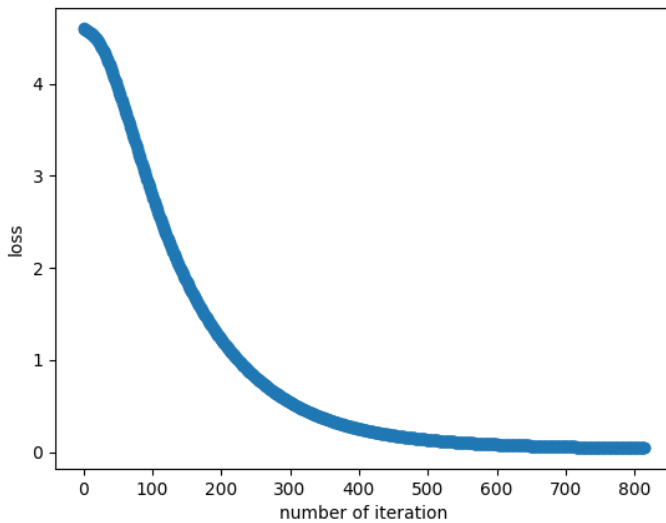
Class 4



Class 6

USING SIFT WITH INTERPOLATION RESIZING AND ALL CLASSES INCLUDED

The loss curve is shown below.

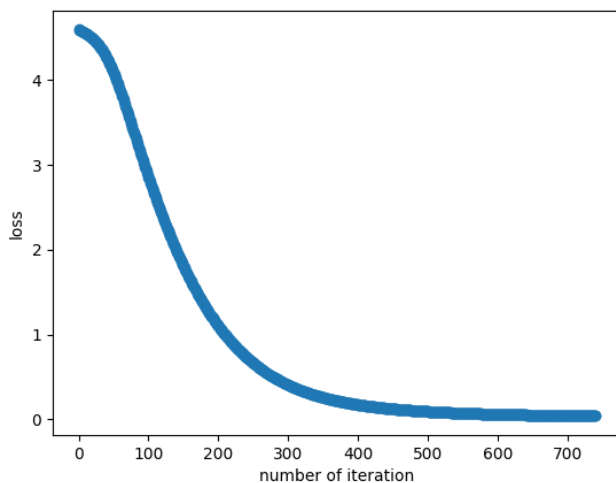


A summarized version of the classification report is shown below, please check out the Appendix (I) for the full version.

	precision	recall	f1-score	support
accuracy			0.72	297
macro avg	0.69	0.73	0.67	297
weighted avg	0.76	0.72	0.70	297

USING SIFT WITH SVG RESIZING AND ALL CLASSES INCLUDED

The loss curve is shown below.

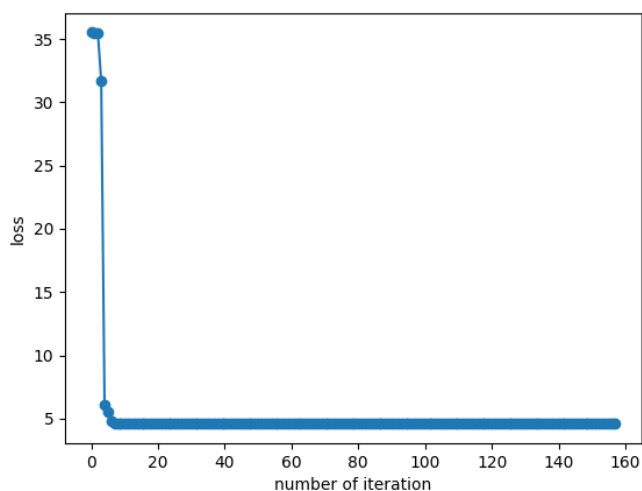


A summarized version of the classification report is shown below, please check out the Appendix (II) for the full version.

	precision	recall	f1-score	support
accuracy			0.73	297
macro avg	0.75	0.74	0.72	297
weighted avg	0.79	0.73	0.73	297

USING RAW IMAGE WITH INTERPOLATION RESIZING AND ALL CLASSES INCLUDED

The loss curve is shown below.

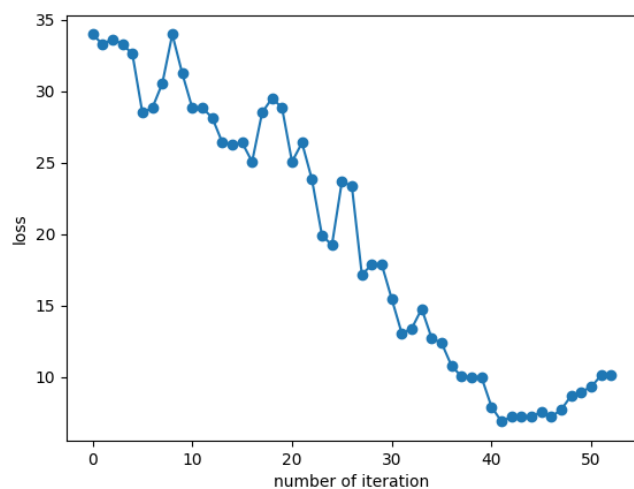


A summarized version of the classification report is shown below, please check out the Appendix (III) for the full version.

accuracy			0.01	297
macro avg	0.00	0.03	0.00	297
weighted avg	0.00	0.01	0.00	297

USING RAW IMAGE WITH INTERPOLATION RESIZING AND A REDUCED NUMBER OF CLASSES

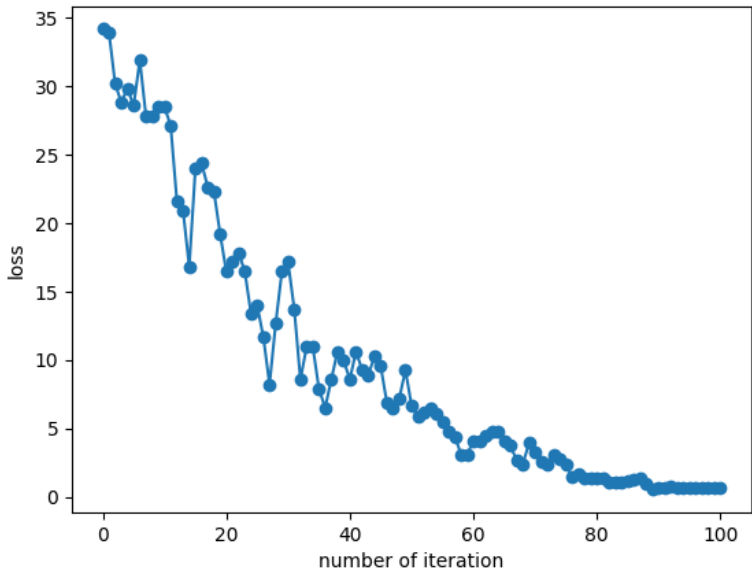
The loss curve is shown below.



The classification report is shown below.

	precision	recall	f1-score	support
1	0.50	0.25	0.33	4
2	1.00	0.60	0.75	5
3	0.80	1.00	0.89	4
4	0.00	0.00	0.00	0
5	0.00	0.00	0.00	2
6	0.00	0.00	0.00	2
7	0.00	0.00	0.00	3
8	0.33	0.67	0.44	3
9	0.33	0.25	0.29	4
10	0.50	0.60	0.55	5
11	0.00	0.00	0.00	1
12	0.00	0.00	0.00	2
13	0.20	0.25	0.22	4
14	0.00	0.00	0.00	4
15	1.00	0.50	0.67	2
accuracy			0.36	45
macro avg	0.31	0.27	0.28	45
weighted avg	0.40	0.36	0.36	45

USING RAW IMAGE WITH SVG RESIZING AND A REDUCED NUMBER OF CLASSES



The classification report is shown below.

	precision	recall	f1-score	support
1	0.50	1.00	0.67	4
2	1.00	0.80	0.89	5
3	1.00	1.00	1.00	4
4	0.00	0.00	0.00	0
5	0.25	0.50	0.33	2
6	0.40	1.00	0.57	2
7	1.00	1.00	1.00	3
8	0.50	0.33	0.40	3
9	0.00	0.00	0.00	4
10	1.00	0.40	0.57	5
11	1.00	1.00	1.00	1
12	0.00	0.00	0.00	2
13	0.60	0.75	0.67	4
14	1.00	0.75	0.86	4
15	0.50	0.50	0.50	2
accuracy			0.64	45
macro avg	0.58	0.60	0.56	45
weighted avg	0.67	0.64	0.62	45

APPENDIX

I)

class	precision	recall	f1-score	support
0	1.00	1	1	4
1	1.00	1	1	1
2	1.00	1	1	3
3	1.00	1	1	6
4	1.00	1	1	2
5	1.00	1	1	3
6	1.00	1	1	2
7	1.00	1	1	6
8	0.25	1	0.4	1
9	1.00	1	1	2
10	1.00	0.75	0.86	4
11	1.00	1	1	4
12	0.67	1	0.8	2
13	1.00	1	1	2
14	1.00	1	1	4
15	1.00	1	1	1
17	1.00	0.67	0.8	3
18	0.00	0	0	3
19	1.00	1	1	5

20	0.67	0.67	0.67	3
21	1.00	1	1	1
22	0.25	0.67	0.36	3
23	1.00	0.5	0.67	4
24	0.50	1	0.67	1
25	1.00	1	1	3
26	1.00	0.5	0.67	2
27	0.67	0.4	0.5	5
28	0.50	1	0.67	1
29	0.20	0.33	0.25	3
30	0.00	0	0	3
31	0.50	1	0.67	2
32	0.50	0.67	0.57	3
33	1.00	0.8	0.89	5
34	1.00	0.4	0.57	5
35	1.00	0.67	0.8	3
36	0.00	0	0	0
37	0.33	1	0.5	1
38	0.00	0	0	3
39	0.40	0.67	0.5	3
40	0.00	0	0	1
41	0.67	1	0.8	4
42	1.00	1	1	3
43	0.67	1	0.8	2
44	0.00	0	0	0
45	1.00	1	1	3
46	1.00	1	1	1
47	1.00	1	1	3
48	1.00	0.43	0.6	7
49	1.00	1	1	3
50	1.00	0.75	0.86	4
51	1.00	1	1	1
52	1.00	0.67	0.8	3
53	0.40	0.67	0.5	3
54	0.33	1	0.5	1
55	0.17	1	0.29	1
56	0.57	1	0.73	4
57	0.33	0.5	0.4	2
58	1.00	0.67	0.8	3
59	0.00	0	0	2
60	0.00	0	0	1
61	0.40	1	0.57	2
62	1.00	1	1	3

63	0.33	0.5	0.4	2
64	0.80	0.8	0.8	5
65	0.75	0.75	0.75	4
66	1.00	0.5	0.67	2
67	0.00	0	0	4
68	1.00	0.8	0.89	5
69	0.67	0.67	0.67	3
70	0.75	0.6	0.67	5
71	1.00	1	1	2
72	1.00	0.17	0.29	6
73	0.43	1	0.6	3
74	1.00	1	1	1
75	1.00	1	1	4
76	1.00	1	1	2
77	0.67	0.57	0.62	7
78	1.00	1	1	3
79	1.00	1	1	3
80	0.80	1	0.89	4
81	0.00	0	0	3
82	0.50	0.67	0.57	3
83	0.50	1	0.67	1
84	0.00	0	0	0
85	1.00	1	1	5
86	0.00	0	0	4
87	0.50	0.25	0.33	4
88	0.33	1	0.5	2
89	0.67	1	0.8	2
90	0.50	0.5	0.5	6
91	1.00	0.2	0.33	5
92	1.00	1	1	3
93	0.67	1	0.8	2
94	0.75	1	0.86	3
95	1.00	1	1	5
96	0.33	0.33	0.33	3
97	1.00	0.57	0.73	7
98	1.00	1	1	5
accuracy			0.72	297
macro	avg	0.69	0.73	0.67
avg	0.76	0.72	0.7	297

II)

id	precision	recall	f1-score	support
0	0.8	1	0.89	4
1	1	1	1	1
2	1	1	1	3
3	1	0.83	0.91	6
4	1	1	1	2
5	1	1	1	3
6	1	1	1	2
7	1	1	1	6
8	1	1	1	1
9	1	1	1	2
10	0.75	0.75	0.75	4
11	0.75	0.75	0.75	4
12	0.5	1	0.67	2
13	1	1	1	2
14	0.8	1	0.89	4
15	1	1	1	1
16	0	0	0	0
17	1	1	1	3
18	0.75	1	0.86	3
19	1	1	1	5
20	1	0.67	0.8	3
21	1	1	1	1
22	1	1	1	3
23	0.67	0.5	0.57	4
24	0	0	0	1
25	1	0.67	0.8	3
26	1	0.5	0.67	2
27	0.8	0.8	0.8	5
28	1	1	1	1
29	0.5	0.67	0.57	3
30	0.67	0.67	0.67	3
31	1	0.5	0.67	2
32	0.6	1	0.75	3
33	1	0.8	0.89	5
34	1	0.8	0.89	5
35	1	1	1	3
37	0.5	1	0.67	1
38	1	0.67	0.8	3
39	0.67	0.67	0.67	3
40	0	0	0	1
41	0.6	0.75	0.67	4

42	1	1	1	3
43	0.5	1	0.67	2
45	1	1	1	3
46	1	1	1	1
47	1	1	1	3
48	1	0.43	0.6	7
49	1	1	1	3
50	1	0.75	0.86	4
51	0.5	1	0.67	1
52	1	1	1	3
53	0.75	1	0.86	3
54	0.25	1	0.4	1
55	0	0	0	1
56	0.8	1	0.89	4
57	0	0	0	2
58	0.75	1	0.86	3
59	1	1	1	2
60	1	1	1	1
61	1	1	1	2
62	0.5	0.33	0.4	3
63	1	0.5	0.67	2
64	0.6	0.6	0.6	5
65	0.43	0.75	0.55	4
66	1	0.5	0.67	2
67	0.67	0.5	0.57	4
68	1	0.2	0.33	5
69	1	0.67	0.8	3
70	0.83	1	0.91	5
71	1	1	1	2
72	0.56	0.83	0.67	6
73	0.67	0.67	0.67	3
74	0	0	0	1
75	1	1	1	4
76	0.5	0.5	0.5	2
77	0.5	0.14	0.22	7
78	1	1	1	3
79	1	0.67	0.8	3
80	0.67	0.5	0.57	4
81	0.5	0.67	0.57	3
82	0.6	1	0.75	3
83	0.33	1	0.5	1
84	0	0	0	0
85	1	1	1	5

86	1	0.5	0.67	4
87	0.25	0.25	0.25	4
88	0.33	0.5	0.4	2
89	1	1	1	2
90	1	0.5	0.67	6
91	1	0.6	0.75	5
92	0.33	0.67	0.44	3
93	0.67	1	0.8	2
94	1	0.67	0.8	3
95	0.8	0.8	0.8	5
96	0	0	0	3
97	0	0	0	7
98	1	0.8	0.89	5
accuracy	0.73	297		
macro avg	0.75	0.74	0.72	297
weighted avg	0.79	0.73	0.73	297

III)

class	precision	Recall	f1-score	support
0	0	0	0	6
1	0	0	0	3
2	0	0	0	4
3	0	0	0	3
5	0	0	0	1
6	0	0	0	1
7	0	0	0	3
8	0	0	0	3
9	0	0	0	2
10	0	0	0	5
11	0	0	0	0
12	0	0	0	1
13	0	0	0	4
14	0	0	0	3
15	0	0	0	2
16	0	0	0	2
17	0	0	0	2
18	0	0	0	4
20	0.14	1	0.25	1
21	0	0	0	2
22	0	0	0	2

23	0	0	0	1
24	0	0	0	2
25	0	0	0	3
26	0	0	0	3
27	0	0	0	0
28	0	0	0	5
29	0	0	0	2
30	0	0	0	2
31	0.05	1	0.09	1
32	0	0	0	1
33	0	0	0	3
34	0	0	0	3
35	0	0	0	1
36	0	0	0	3
37	0	0	0	4
38	0	0	0	2
39	0	0	0	3
40	0	0	0	3
41	0	0	0	2
42	0	0	0	7
43	0	0	0	3
44	0	0	0	5
45	0	0	0	3
46	0	0	0	3
47	0	0	0	5
48	0	0	0	3
49	0	0	0	3
50	0	0	0	3
51	0	0	0	3
52	0	0	0	3
53	0	0	0	6
54	0	0	0	2
55	0	0	0	4
56	0	0	0	1
57	0	0	0	3
58	0	0	0	1
59	0	0	0	1
60	0	0	0	7
61	0	0	0	5
62	0.03	1	0.07	1
63	0	0	0	2
64	0	0	0	4
65	0	0	0	2

66	0	0	0	3
67	0	0	0	2
68	0	0	0	4
69	0	0	0	1
70	0	0	0	4
71	0	0	0	3
72	0	0	0	3
73	0	0	0	1
74	0	0	0	2
75	0	0	0	4
76	0	0	0	1
77	0	0	0	3
78	0	0	0	3
79	0	0	0	6
80	0	0	0	4
81	0	0	0	3
82	0	0	0	2
83	0	0	0	3
84	0	0	0	4
85	0	0	0	5
86	0	0	0	4
87	0	0	0	3
88	0	0	0	3
89	0	0	0	2
90	0	0	0	4
91	0	0	0	4
92	0	0	0	7
93	0	0	0	5
94	0	0	0	5
95	0	0	0	5
96	0	0	0	6
97	0	0	0	5
98	0	0	0	5
accuracy			0.01	297
macro avg	0	0.03	0	297
weighted avg	0	0.01	0	297