**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 accuracy of 0.72 and average F1 score of 0.7. When I fed the raw image (resized, flattened, and 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 accuracy of 0.36 and average F1 score of 0.36.

**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 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.

**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. When the resized images were used there was an additional boost to the performance for the Raw Image Classifier but no improvement for the SIFT classifier.

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

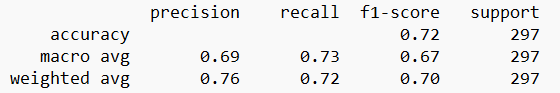
**USING SIFT WITH INTERPOLATION RESIZED IMAGES**

The loss curve is shown below.

A picture containing shape

Description automatically generated

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



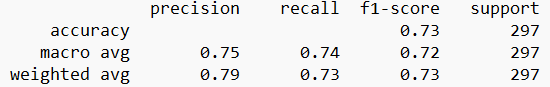
**USING SIFT WITH SVG RESIZED IMAGES**

The loss curve is shown below.

A picture containing chart

Description automatically generated

A summarized version of the classification report is shown below.



**USING MLP WITH INTERPOLATION RESIZED IMAGE**

The loss curve is shown below.

Shape

Description automatically generated

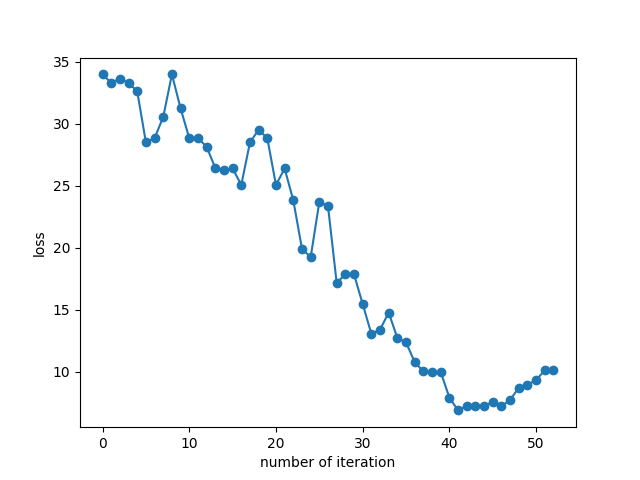
A summarized version of the classification report is shown below, please check out the Appendix (II) for the full version.

A picture containing graphical user interface

Description automatically generated

**USING MLP WITH INTERPOLATION RESIZED IMAGE AND A REDUCED NUMBER OF CLASSES**

The loss curve is shown below.



The classification report is shown below.

Table

Description automatically generated

**USING SVG RESIZED IMAGE WITH A REDUCED NUMBER OF CLASSES**

Chart, scatter chart

Description automatically generated

The classification report is shown below.

Table

Description automatically generated

**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)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **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 |