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CS 429

HW 4 Writeup

From Part 1 of this assignment, the non-kerneled SVM model actually produced a decent output. This output held an accuracy of 42.29% (Fig 1A) when identifying the Aurora images using all 768 components. This compared to the post-kerneled SVM's in Fig 1B-D show that the accuracy didn't increase very significantly over time. The output for the linear kerneled-SVM was 42.29%, which was actually a decrease from the normal SVM, and the output for the sigmoid kerneled-SVM was 49.26%, an increase from the base model we had first discovered.

This lack of increase makes a strong case that this type of model is more sigmoid leaning, even through in previous assignments we had found that using a perceptron with a linear step activation / regression model had the most increase in accuracy.

After analyzing the original extracted feature vectors using PCA, I saw a large increase in variance after around the 20th feature component. This was later confirmed by (Fig 2A-2B) rerunning the SVM model post PCA on multiple instances of n_components, and showing no change after the 20th feature values being kept. The outstanding data found after using a PCA on the data, then running this through to create and classify a SVM model and predictions, was the accuracy that came from this shown below.

Post PCA SVM model accuracy using n feature values:

n_features	5	10	20	50	100	200	768
accuracy	51.47%	50.98%	50.74%	50.74%	50.74%	50.74%	50.74%

The highest accuracy found post-PCA was around the 5 feature mark, and anything after had a decrease in accuracy and stagnated to 50.74% over time. I at first thought I had messed up the PCA process and looked back through my work, but after careful examination of my code, the model being updated, and much more, I found this not to be the case. The model did not take any more information or increase its accuracy after 5 features were read. This is still very strange to me, but considering that there was a large increase in variance after around the 20th feature component as stated before, I think this makes sense.

The overall findings from using a kernel, PCA, and different features on a SVM model did not seem to make a large difference or increase accuracy as well as the perceptron performance in the previous homework, and from the data I've gathered – for best results – I would suggest the perceptron classification model as the basis for improving accuracy from this data set.

Project Notes:

I had used the same number of training and validation images from homework 2, ~1200 total, written to separate files and manually moved into validation and training sets. These sets can be found within files described in the README.txt file in the project submission folder, but they will not contain the same exact histograms as provided in the figures below and writeup above as I did manual research following completing this assignment and cannot return the files to their original format.

Fig 1A Svm: pre-PCA, pre-kernel:

```
Computing XiAlpha-estimates...done
Runtime for XiAlpha-estimates in cpu-seconds: 0.00
XiAlpha-estimate of the error: error<=33.58% (rho=1.00,depth=0)
XiAlpha-estimate of the recall: recall=>67.33% (rho=1.00,depth=0)
XiAlpha-estimate of the precision: precision=>66.67% (rho=1.00,depth=0)
Number of kernel evaluations: 5675
Writing model file...done
PS C:\Users\Jack Volonte\PycharmProjects\hw2\svm_light> .\svm_classify svmModelThing\histo_val.dat svmModelThing\model svmModelThing\predictions
Reading model...OK. (140 support vectors read)
Classifying test examples..100..200..300..400..done
Runtime (without IO) in cpu-seconds: 0.00
Accuracy on test set: 43.14% (176 correct, 232 incorrect, 408 total)
Precision/recall on test set: 42.29%/42.29%
PS C:\Users\Jack Volonte\PycharmProjects\hw2\svm_light> 
```

Fig 1B Svm: pre-PCA, post_linear-kernel:

```
Computing XiAlpha-estimates...done
Runtime for XiAlpha-estimates in cpu-seconds: 0.00
XiAlpha-estimate of the error: error<=33.58% (rho=1.00,depth=0)
XiAlpha-estimate of the recall: recall=>67.33% (rho=1.00,depth=0)
XiAlpha-estimate of the precision: precision=>66.67% (rho=1.00,depth=0)
Number of kernel evaluations: 5675
Writing model file...done
PS C:\Users\Jack Volonte\PycharmProjects\hw2\svm_light> .\svm_classify svmModelThing\histo_val.dat svmModelThing\model svmModelThing\predictions
Reading model...OK. (140 support vectors read)
Classifying test examples..100..200..300..400..done
Runtime (without IO) in cpu-seconds: 0.00
Accuracy on test set: 43.14% (176 correct, 232 incorrect, 408 total)
Precision/recall on test set: 42.29%/42.29%
PS C:\Users\Jack Volonte\PycharmProjects\hw2\svm_light> 
```

Fig 1C Svm: pre-PCA, post_radial-basis kernel:

```
Computing XiAlpha-estimates...done
Runtime for XiAlpha-estimates in cpu-seconds: 0.00
XiAlpha-estimate of the error: error<=11.53% (rho=1.00,depth=0)
XiAlpha-estimate of the recall: recall=>89.11% (rho=1.00,depth=0)
XiAlpha-estimate of the precision: precision=>88.24% (rho=1.00,depth=0)
Number of kernel evaluations: 33391
Writing model file...done
PS C:\Users\Jack Volonte\PycharmProjects\hw2\svm_light> .\svm_classify svmModelThing\histo_val.dat svmModelThing\model svmModelThing\predictions
Reading model...OK. (58 support vectors read)
Classifying test examples..100..200..300..400..done
Runtime (without IO) in cpu-seconds: 0.01
Accuracy on test set: 41.67% (170 correct, 238 incorrect, 408 total)
Precision/recall on test set: 41.06%/42.29%
PS C:\Users\Jack Volonte\PycharmProjects\hw2\svm_light> 
```

Fig 1D Svm: pre-PCA, post_sigmoid kernel:

```

Computing XiAlpha-estimates...done
Runtime for XiAlpha-estimates in cpu-seconds: 0.00
XiAlpha-estimate of the error: error<=98.75% (rho=1.00,depth=0)
XiAlpha-estimate of the recall: recall=>2.48% (rho=1.00,depth=0)
XiAlpha-estimate of the precision: precision=>2.48% (rho=1.00,depth=0)
Number of kernel evaluations: 89471
Writing model file...done
PS C:\Users\Jack Volonte\PycharmProjects\hw2\svm_light> .\svm_classify svmModelThing\histo_val.dat svmModelThing\model svmModelThing/predictions
Reading model...OK. (394 support vectors read)
Classifying test examples..100..200..300..400..done
Runtime (without IO) in cpu-seconds: 0.16
Accuracy on test set: 49.26% (201 correct, 207 incorrect, 408 total)
Precision/recall on test set: 49.26%/100.00%
PS C:\Users\Jack Volonte\PycharmProjects\hw2\svm_light> 

```

Post PCA:

Fig 2A n_components = 5

```

L1 loss: loss=10.81012
Norm of weight vector: |w|=16.71370
Norm of longest example vector: |x|=0.80351
Estimated VCdim of classifier: VCdim<=118.29498
Computing XiAlpha-estimates...done
Runtime for XiAlpha-estimates in cpu-seconds: 0.00
XiAlpha-estimate of the error: error<=7.69% (rho=1.00,depth=0)
XiAlpha-estimate of the recall: recall=>92.06% (rho=1.00,depth=0)
XiAlpha-estimate of the precision: precision=>92.52% (rho=1.00,depth=0)
Number of kernel evaluations: 12875
Writing model file...done
PS C:\Users\Jack Volonte\PycharmProjects\hw2\svm_light> .\svm_classify svmModelThing\histo_val.dat svmModelThing\model svmModelThing/predictions
Reading model...OK. (65 support vectors read)
Classifying test examples..100..200..300..400..done
Runtime (without IO) in cpu-seconds: 0.00
Accuracy on test set: 50.74% (207 correct, 201 incorrect, 408 total)
Precision/recall on test set: -1.#J%/0.00%
PS C:\Users\Jack Volonte\PycharmProjects\hw2\svm_light> 

```

Fig 2B n_components = 20

```

L1 loss: loss=10.81012
Norm of weight vector: |w|=16.71370
Norm of longest example vector: |x|=0.80351
Estimated VCdim of classifier: VCdim<=118.29498
Computing XiAlpha-estimates...done
Runtime for XiAlpha-estimates in cpu-seconds: 0.00
XiAlpha-estimate of the error: error<=7.69% (rho=1.00,depth=0)
XiAlpha-estimate of the recall: recall=>92.06% (rho=1.00,depth=0)
XiAlpha-estimate of the precision: precision=>92.52% (rho=1.00,depth=0)
Number of kernel evaluations: 12875
Writing model file...done
PS C:\Users\Jack Volonte\PycharmProjects\hw2\svm_light> .\svm_classify svmModelThing\histo_val.dat svmModelThing\model svmModelThing/predictions
Reading model...OK. (65 support vectors read)
Classifying test examples..100..200..300..400..done
Runtime (without IO) in cpu-seconds: 0.00
Accuracy on test set: 50.74% (207 correct, 201 incorrect, 408 total)
Precision/recall on test set: -1.#J%/0.00%
PS C:\Users\Jack Volonte\PycharmProjects\hw2\svm_light> 

```

Fig 2B n_components = 768