CMPE 462 PROJECT 2

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May 2020

Task 1

We have used the software package LIBSVM to train a hard margin linear SVM. For this purpose, we have given "-s 0 -c 1000 -t 0" as the parameters. The option '-s 0' sets the type of the SVM as C-SVC. Since we want to train a hard margin SVM, the variable C should be a big number, so the option '-c 1000' sets C to 1000. And lastly, as we want a linear SVM, we give the '-t 0' parameter, which sets the kernel function to be a linear function.

Then we have used the "svm_predict" function of the LIBSVM's Python interface to get the training and test classification accuracies, which outputs the classification accuracy to the console.

With these parameters, we have got the following results:
Training classification accuracy: 90% (135/150)
Test classification accuracy: 81.67% (98/120)

Task 2

In this task, we have again used the same functions from the LIBSVM Pyhton interface as the previous task, this time with different parameters. To change the C value we simply change the value we pass to the option '-c' and to change the type of the kernel function we change the value we pass to the option '-t'

As we want the SVM to be soft margin, we have decreased the value of C to relax the classifier. We have chosen to set $C = 50$ and try with different kernel functions. The best results were with the linear kernel function, therefore we have decided to experiment with different C values with the linear kernel function. We have set $C = 1, 2, 5, 10, 100$ and observed that lower C values resulted in a lower training classification accuracy but a higher test classification accuracy. This makes sense, as increasing the C value results in more overfitting to the training data.

Task 3

When C is large, It means that we care more about violating the margin, which gets us closer to the hard-margin SVM. If we allow bigger margin(soft-margin SVM), we should have a large number of support vectors. So,getting closer to hard margin via increasing C, gives us less number of support vectors as theory suggests. We built models with different C values:

model_CValue = svm_train(Y_train,X_train, "-s 0 -c CValue -t 0")

C value	#of Support Vectors
1	58
2	56
5	54
10	51
100	50

Task 4

In this part, we removed a SV data point(Last SV at indices) from our training data and rebuilt model with new training data. Then we investigated the changes in terms of support vectors and weights. We applied exactly same procedure with removing a non-SV data point.
When we delete SV point, weights and support vector set changed.
When we delete non-SV point, weights changed very little and support vector set does not changed.

Weights before removal:
{-1.308960694997034, 0.5255770615861053, 1.3470379341678012, 1.3786551708896582, 1.6279048137817682, 0.1613750898546158, 0.13202185984296477, -1.8521656608970147, -0.02557950197261505, -0.07641398739398397, 0.06905809226138615, 2.724943229661587, 0.44802622958216887}

SV indices before removal:
{3, 14, 18, 29, 31, 38, 41, 45, 48, 59, 62, 68, 70, 92, 98, 102, 106, 109, 111, 113, 117, 131, 132, 145, 147, 2, 4, 6, 11, 12, 15, 23, 24, 27, 32, 53, 61, 69, 75, 77, 85, 86, 88, 97, 125, 126, 133, 135, 140, 144}

Weights after removal of a SV data point:
{-1.1673892919251294, 0.49414569555652577, 1.3248126614021913, 1.2582097233898324, 1.3529999359566318, 0.02632799958355747, 0.04065292518397712, -1.9722469759555192, -0.013711859744105936, -0.08426744210563442, 0.28936196029015093, 2.8689328636374505,

0.3817702423921645}

SV indices after removal of a SV data point:
{3, 14, 18, 29, 31, 38, 41, 45, 48, 59, 62, 68, 70, 92, 98, 102, 106, 109, 111, 113, 117, 131, 132, 146, 147, 2, 4, 6, 11, 12, 15, 23, 24, 27, 32, 53, 61, 69, 75, 77, 85, 86, 88, 97, 125, 126, 133, 135, 140, 144}

Set difference between SV's indices before and after removal of a SV data point.
{146}

Weights after removal of a non-SV data point:
{-1.3086316401552454, 0.5256006629586949, 1.3469603720069614, 1.3786885050173652, 1.6271960978388833, 0.16120481773926087, 0.1318102270245589, -1.8519201307924433, -0.02569283304457315, -0.07611806373145669, 0.06924638672929007, 2.72501607171343, 0.4479868715526578}

SV indices after removal of a non-SV data point:
{3, 14, 18, 29, 31, 38, 41, 45, 48, 59, 62, 68, 70, 92, 98, 102, 106, 109, 111, 113, 117, 131, 132, 145, 147, 2, 4, 6, 11, 12, 15, 23, 24, 27, 32, 53, 61, 69, 75, 77, 85, 86, 88, 97, 125, 126, 133, 135, 140, 144}

Set difference between SV's indices before and after removal of a non-SV data point.
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