Ryan Torelli
11481335
April 10, 2018
CptS 437: Homework #5

4. Support Vector Machine for Handwritten Digits Recognition
(a) The svm_with_diff_c() function trains models for different values of a cost parameter and predicts labels on test data. The function prints number of support vectors and test accuracy for cost parameters {0.01, 0.1, 1, 2, 3, 5} using the default radial basis function kernel.

(b) The svm_with_diff_kernel() function trains models for different kernels and predicts labels on test data. The function prints number of support vectors and test accuracy for linear, polynomial, and radial basis function kernels using the default cost parameter of 1.

(c) In soft-margin SVM, the cost parameter is analogous to a regularization parameter that penalizes violations of the margin. As the cost parameter increases, margin size and the number of violations decrease; soft-margin SVM approaches a hard margin. For the handwritten digit dataset, increasing the cost parameter from 0.01 to 5 decreases the number of support vectors and increases test accuracy (Table 1). As the soft margin approaches a hard margin, fewer points violate the boundary such that there are fewer support vectors. For this dataset, a larger cost parameter, and harder margin, has better test accuracy. In modeling the dataset, three different kernels result in similar test accuracy but with the linear and radial basis function kernels having fewest support vectors (Table 2).

Table 1. Support vectors and test accuracy for varying cost with default radial basis function kernel.

Cost	nSV	Test Acc, %
0.01	1112	88.68
0.1	424	95.99
1	163	95.99
2	131	95.99
3	117	96.23
5	104	96.23

Table 2. Support vectors and test accuracy for different kernels with default cost of 1.

Kernel	nSV	Test Acc, %
linear	162	95.99
poly	543	95.52
radial basis	163	95.99