Short Assignment 4

This is an individual assignment.

For the analytical problems, you can write your answers in markdown cells with $\LaTeX$ or `push` a single pdf to your repository with all handwritten answers.

- *Always* show complete work and justify your answers.

Exercise 1 (3 points)

Recall that the soft-margin Support Vector Machine objective function is

$$C\sum_{n=1}^{N}\xi_n + \frac{1}{2}\|w\|^2$$

subject to the constraints

$$t_n y(x_n) \geq 1 - \xi_n, n = 1, \ldots, N$$
$$\xi_n \geq 0, n = 1, \ldots, N$$

Answer the following questions:

1. (1.5 points) **From the training set, which points are used to make predictions during the test stage? Explain your reasoning.**

2. (1.5 points) C **is a parameter that is set by the user. Describe the relationship between values of** C **and (1) the resulting SVM decision surface, (2) performance and (3) number of support vectors.**

1. The **support vectors** are used to make predictions because they are the data points that lie closest to the decision boundary and have a non-zero value of ξ_n .

2. A small value of C will result in a wider margin and fewer support vectors, but may lead to poor classification performance on the training set. Conversely, a large value of C will result in a narrower margin and more support vectors, but may lead to overfitting and poor generalization performance on the test set .

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Exercise 2 (6 points)

Complete the following table for the classifiers listed below (3 points/classifier). Under "Type" list: generative, discriminative or probabilistic discriminative. Under "Convergence" list whether the convergence is guaranteed or any other conditions for the converged solution.

Classifier	Type	Mapper function	Objective Function	Learning Algorithm	Assumptions	Computational Complexity	Sensitive to outliers?	Convergen
Naïve Bayes Classifier								
Fisher's LDA								
Perceptron								
Logistic Regression								
Hard-margin SVM								
Soft-margin SVM								

Classifier	Type	Mapper function	Objective Function	Learning Algorithm	Assumptions	Computationa Complexity
Naïve Bayes Classifier	Probabilistic discriminative	contingent probability	Maximum likelihood estimation	Maximum a posteriori estimation	Conditional independence between features	$O(Nkd)$, where N is the number of training

Classifier	Type	Mapper function	Objective Function	Learning Algorithm	Assumptions	Computationa Complexity
						examples, k is the number of classes, and d i the number of features
Fisher's LDA	Generative	contingent probability	Maximizing the between-class variance and minimizing the within-class variance	Fisher's linear discriminant	Normality, homoscedasticity, and linearity of the data	$O(d^2N)$, where d is the number of features and N is the number of training examples
Perceptron	Discriminative	f(x) = g(w^Tx)	Minimizing the number of misclassifications	Stochastic gradient descent	Linearly separable data	$O(Nd)$, where N is the number of training examples and d is the number of features
Logistic Regression	Probabilistic discriminative	contingent probability	Maximum likelihood estimation	Gradient descent	Linearity of the log-odds	$O(Nd)$, where N is the number of training examples and d is the number of features
Hard-margin SVM	Discriminative	f(x)=g(w^Tx)	Maximizing the margin	Quadratic programming	Linearly separable data	$O(N^3)$, where N is the number of training examples
Soft-margin SVM	Discriminative	f(x) = g(w^Tx)	Maximizing the margin and minimizing the classification error	Quadratic programming	Linearly separable data	$O(N^3)$, where N is the number of training examples

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On-Time (1 point)

Submit your assignment before the deadline.

Submit Your Solution

Confirm that you've successfully completed the assignment.

Along with the Notebook, include a PDF of the notebook with your solutions.

`add` and `commit` the final version of your work, and `push` your code to your GitHub repository.

Submit the URL of your GitHub Repository as your assignment submission on Canvas.
