Homework 2

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Problem 2-1. A Walk Through Linear Models

(a) Perceptron

Answer:

1. (1) size of training set is 10:
   training error rate: 0.0
   testing error rate: 10.79% (using 1000 test samples)
   (2) size of training set is 100:
   training error rate: 0.29%
   testing error rate: 0.16% (using 1000 test samples)
2. (1) size of training set is 10:
   Average number of iterations: 53.75
   (2) size of training set is 100:
   Average number of iterations: 1750.7
3. if the training data is not linearly separable, Perceptron function will never converge. So we need to set a fix maximum number of iterations.
   training error rate: 22.81% testing error rate: 23.92% Average number of iterations: 5000.0 (5000 is maximum number of iterations, which proves Perceptron function does not converge)

(b) Linear Regression

Answer:

1. training error: 3.89%
   size of testing data: 1000
   testing error: 4.84%
2. training error: 13.15%
   size of testing data: 1000
   testing error: 14.39%
3. training error: 49%
   testing error: 54.96%
4. training error: 5%
   testing error: 6.6%

(c) Logistic Regression

Answer:

1. training error: 0.69%
   size of testing data: 1000
   testing error: 1.40%
2. training error: 14.35%
   size of testing data: 1000
   testing error: 15.83%

(d) Support Vector Machine

Answer:

1. training error: 0
   size of testing data: 10000
   testing error: 3.47%
2. training error: 0
   size of testing data: 10000
   testing error: 1.04%
3. if we count all sample x_i, such that $0.95 < y_i w^T x_i < 1.05$, then average number of support vectors: 2.433.

Problem 2-2. Regularization and Cross-Validation

(a) Implement Ridge Regrssion, and use LOOCV to tune the regularization parameter λ.

Answer:

1. 1e2
2. with regularization: 0.16
   without regularization: 1.42
3. with regularization:
   training error: 0
   testing error: 6.58%
   without regularization:
   training error: 0
   testing error: 11.05%

(b) Implement Logistic Regrssion, and use LOOCV to tune the regularization parameter λ.

Answer:

with regularization:
training error: 0
testing error: 5.78%
without regularization:
training error: 0
testing error: 5.78%
λ chosen : 1e-3

Problem 2-3. Bias Variance Trade-off

Let's review the bias-variance decomposition first. Now please answer the following questions:

(a) True of False

Answer:

1. False
2. False
3. True
4. False
5. False