Introduction to Pattern Recognition Homework 1

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1 Program Report

1. **Plot the learning curve of the training, you should find that loss decreases after a few iterations (x-axis=iteration,y-axis=loss, Matplotlibor other plot tools is available to use)**

   For this assignment, we plotted both the actual regression function and the error for each iteraiton of the training and test data sets.

2. **What's the Mean Square Error of your prediction and ground truth (prediction=model(x_test),ground truth = y_test)**

   For the testing data, we got about 0.719 for our slope and 0.635 for our y-intercept.

3. **What're the weights and intercepts of your linear model?**

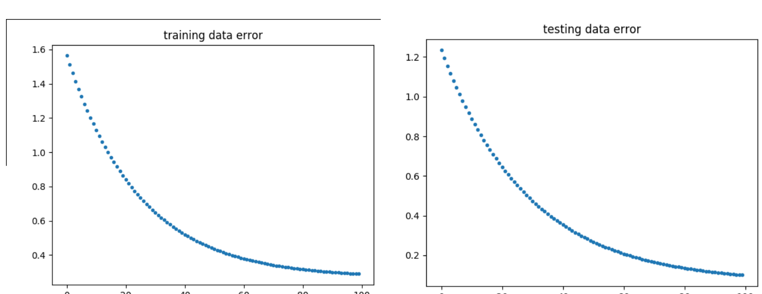
4. **What's the difference between the Gradient Descent, Mini-Batch Gradient Descent, and Stochastic Gradient Descent?**

2 Questions

1. **Suppose that we have three colored boxes R (red), B (blue), and G (green). Box R contains 3 apples, 4 oranges, and 3 guavas, box B contains 2 apples, 0 oranges, and 2 guavas, and box G contains 12 apples, 4 oranges, and 4 guavas. If a box is chosen at random with probabilities $p(R) = 0.2, p(B) = 0.4, p(G) = .4$, and a piece of fruit is removed from the box (with equal probability of selecting any of the items in the box), then what is the probability of selecting guava? If we observe that the selected fruit is in fact an apple, what is the probability that it came from the blue box?**

   For the first question, let b_i refer to choosing box i, and g_i refer to choosing a guava from box i. If we want the probabilites in general of choosing a guava from each of the boxes, we need to add the products $p(b_i)p(g_i)$. Thus our formula becomes

$$\sum_{i=0}^{N} p(b_i)p(g_i)$$



(a) Training Data Error (b) Testing Data Error which evaluates to

$$(.3)(.2) + (.5)(.4) + (.4)(.2) = 0.34$$

For the second question, we want to calculate the probability that the blue box was chosen given that we have chosen an apple. Let a be the event of choosing an apple, and B be the event of choosing the blue box. Then, we would like to find $p(B|a)$. By using **Baye's Theorem**, which states

$$p(A|B) = \frac{p(B|A)p(A)}{p(B)}$$

we can find each of the required probabilities. We are given that $p(B) = .4$. To find $p(a|B)$, we find the probability of choosing an apple from box B, which is $\frac{2}{2+2} = 0.5$. Finally, to find $p(a)$, we repeat the process from the first part, and add the probabilities of choosing box i and picking an apple from that box, which in the end comes out to .5. Thus, our final calculation is

$$p(B|a) = \frac{(.5)(.4)}{(.5)} = .4$$

2. **Using the definition**

$$\mathrm{var}[f] = E[(f(x) - E[f(x)])^2]$$

show that $\mathrm{var}[f(x)]$ satisfies

$$\mathrm{var}[f(x)] = E[f(x)^2] - E[f(x)]^2$$