CSCI 4100 Fall 2018
Assignment 7 Answers

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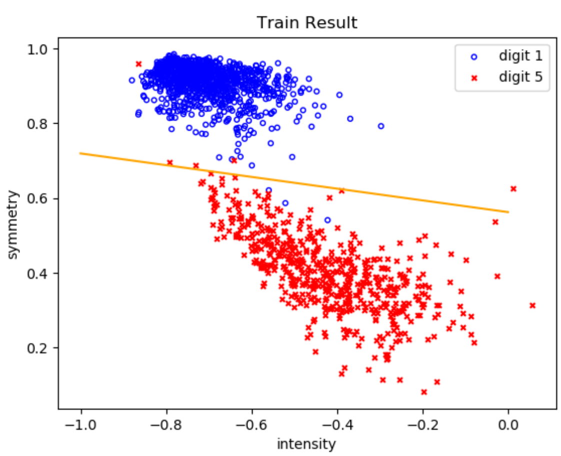
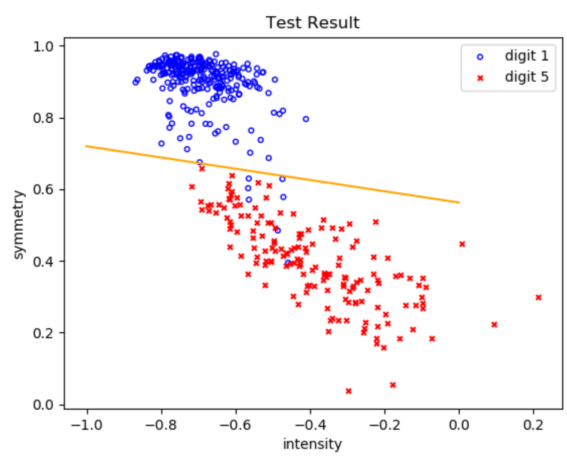
**Classifying Handwritten Digits: 1 vs. 5**

(a)

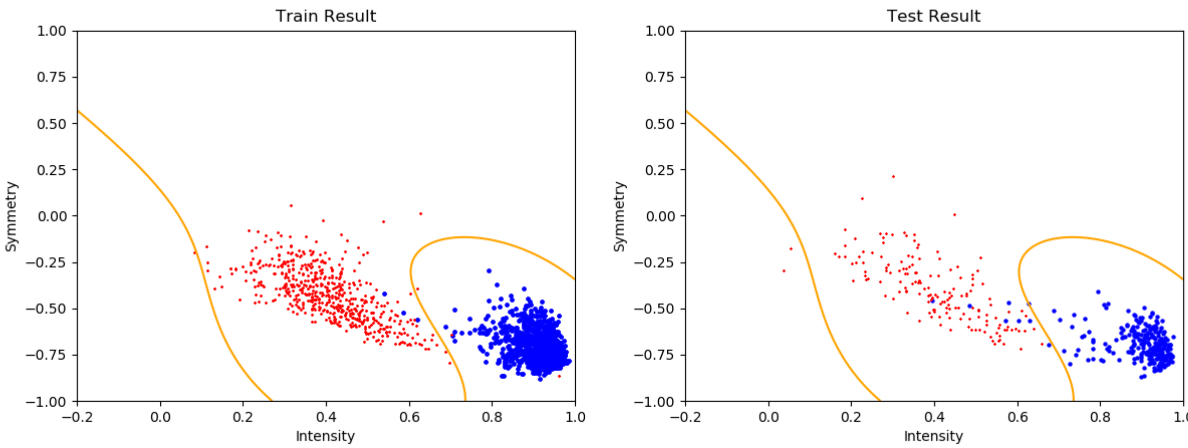



(b) $E_{in} = 0.00512 = 0.512\%$
$E_{test} = 0.0165 = 1.65\%$

(c) Bound based on $E_{in} = 0.0594$
Bound based on $E_{test} = 0.114$

(d) $E_{in} = 0.00448 = 0.448\%$

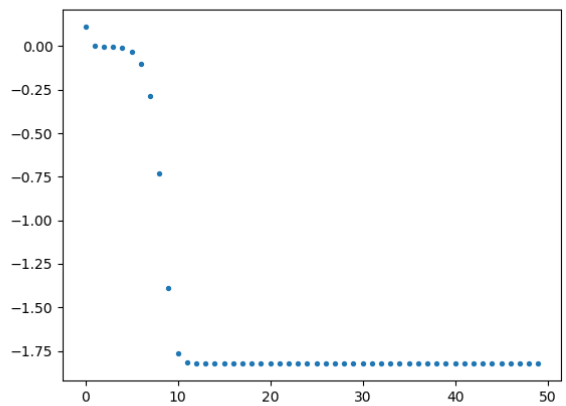


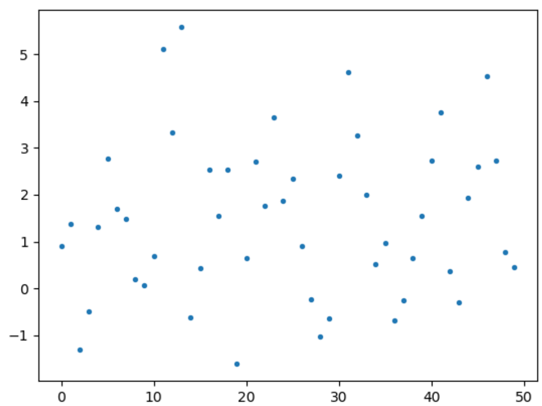

$E_{test} = 0.0212 = 2.12\%$
Bound based on $E_{in} = 0.0601$
Bound based on $E_{test} = 0.115$

(e) I will choose the linear model without the $3^{rd}$ order polynomial transform linear, because the linear transformation will cause overfitting which leads to a larger $E_{out}$

## Gradient Descent on a "Simple" Function

(a) The left one is when learning rate = 0.01 and the right one is when learning rate = 0.1 When




learning rate = 0.1, the value of function jumps up and down.

(b)

| | x | y | f(x,y) |
|---|---|---|---|
| (0.1,0.1) | 0.243804968878158 | -0.237925821319047 | -1.82007854154716 |
| (1,1) | 1.21807030090520 | 0.712811950338754 | 0.593269374325836 |
| (0.5,0.5) | -0.731377459870107 | -0.237855362955527 | -1.33248106233098 |
| (-1,-1) | -1.21807030090520 | -0.712811950338754 | 0.593269374325836 |

**Problem 3.16**

(a) $cost(accept) = P[y = 1|x] \times 0 + P[y = -1|x] \times c_a = (1 - g(x))c_a$
$cost(reject) = P[y = 1|x] \times c_a + P[y = -1|x] \times 0 = g(x)c_a$

(b) Here we only want $cost(accept) \leq cost(reject)$, so

$$(1 - g(x))c_a \leq g(x)c_a$$

$$c_a - g(x)c_a \leq g(x)c_a$$
$$c_a \leq g(x)(c_a + c_r)$$
$$g(x) \geq \frac{c_a}{c_a + c_r}$$

Therefore, when $g(x) \geq \frac{c_a}{c_a+c_r}$, we will accept, so $k = \frac{c_a}{c_a+c_r}$

(c)

$$k_{supermarket} = \frac{1}{1 + 10} = \frac{1}{11}$$
$$l_{CIA} = \frac{1000}{1000 + 1} = \frac{1000}{1001}$$

CIA accept the fingerprint only when g(x) is large.