

# homework 2

Collaborators

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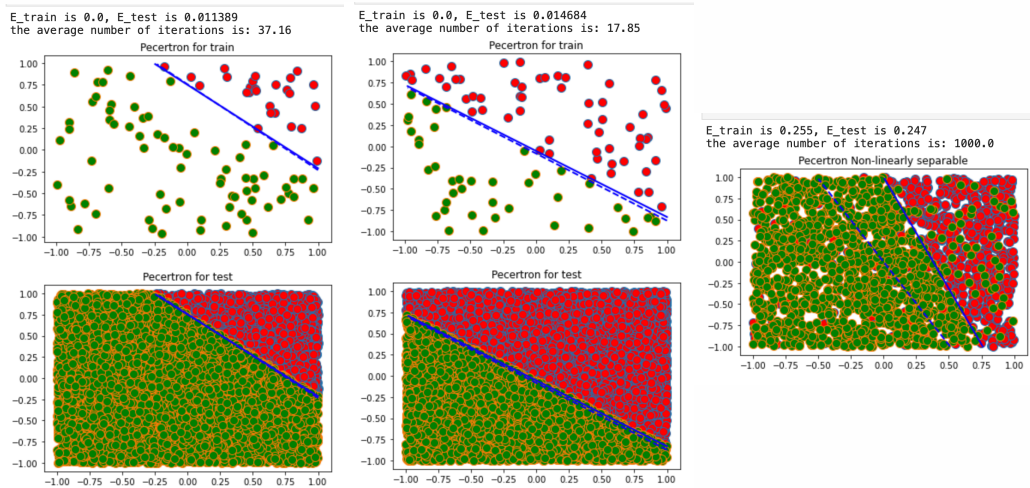
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## Problem 2-1. A Walk Through Linear Modules

### a) perceptron

Answer:

1. when the size of training set is 10  
training error rate:0.0 testing error rate:0.0114  
when the size of training set is 100  
training error rate:0.0 testing error rate:0.0147
2. the average number of iteration:  
when size is 10:37.16  
when size is 100:17.85
3. as for the normal perceptron, the code will fall into a endless loop  
so I add a maxloop number so that it will jump out if iters reaches the maxloop  
but the error rate is about 30%, which means the efficiency is quite low



## b) Linear Regression

Answer:

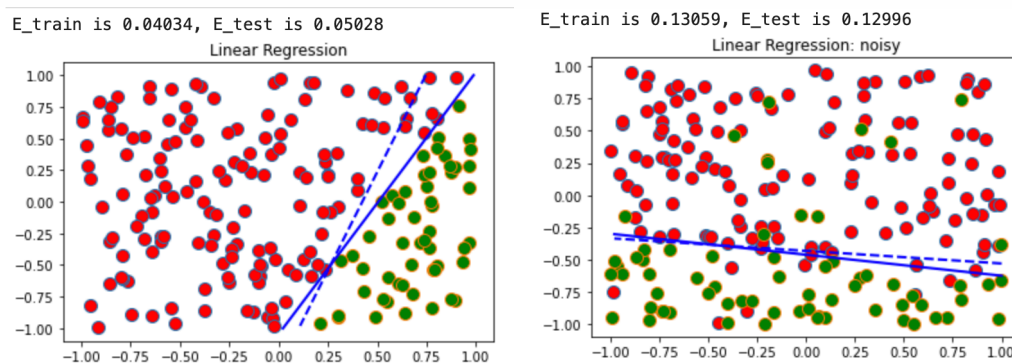
1.training error rate:0.04  
testing error rate:0.05

2.with noisy:  
training error rate:0.13  
testing error rate:0.13

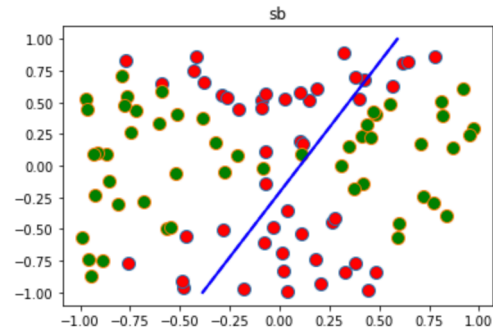
on poly.mat:

3.if not doing the transformation,it can't be linearly saperated:  
training error:0.49  
testing error:0.55

4.if doing the data transformation: $(1, x_1, x_2) \rightarrow (1, x_1, x_2, x_1 x_2, x_1^2, x_2^2)$ :  
training error:0.05  
testing error:0.066



E\_train is 0.49, E\_test is 0.5496



E\_train is 0.05, E\_test is 0.066

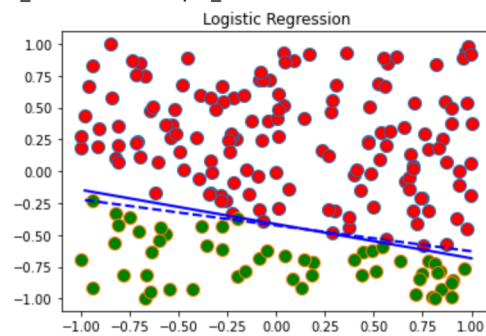
```
[[-0.06872399]  
 [-0.02687646]  
 [ 0.22464875]  
 [ 0.13160111]  
 [-1.84827196]  
 [ 2.00418171]]
```

### c) Logistic Regression

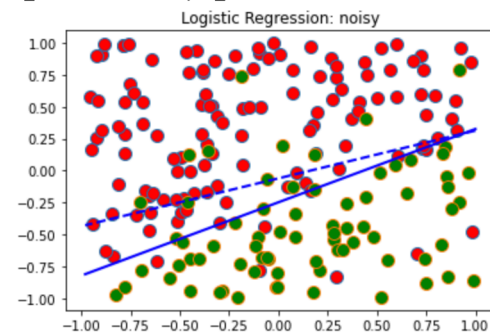
Answer:

- 1.the training size is 100:  
training error: 0.0055  
testing error:0.0128
- 2.with noisy:  
training error: 0.12  
testing error: 0.13

E\_train is 0.0055, E\_test is 0.0128



E\_train is 0.1205, E\_test is 0.1301

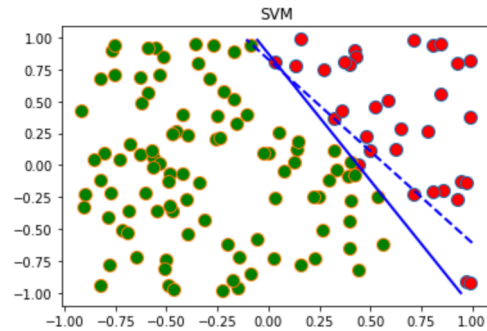


### d) Support Vector Machine

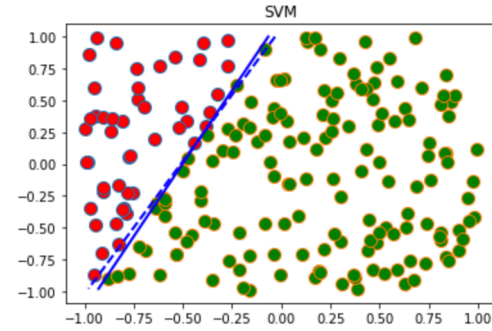
Answer:

- 1.when training size is 30:  
training error:0.0  
testing error:0.0352
- 2.training size is 100:  
training error:0.0  
testing error:0.0085
- 3.the average support vectors is:3.0

E\_train is 0.0, E\_test is 0.0352  
Average number of support vectors is 3.53.



E\_train is 0.0, E\_test is 0.0085  
Average number of support vectors is 3.0.



## Problem 2-2. Regularization and Cross-Validation

### a) Implement Ridge Regression and use LOOCV to tune the regularization parameter $\lambda$

Answer:

1.the  $\lambda$  chosen by LOOCV is 100

2.the  $\sum_{i=1}^n w_i^2$  without regularization is :1.019 with regularization is: 0.133

3.the train error with regularization:0.0 test error: 0.0653

Without regularization: train error:0.0 test error:0.132

```
w without regularization: [[1.01936157]]
the chosen lambda is: 100.0
train error 0.0
test error 0.06529382219989954
```

```
without regularization , train error: 0.0
without regularization , test error 0.13209442491210446
```

### b) Implement Logistic Regression and use LOOCV to tune the regularization parameter $\lambda$

Answer:

1.the  $\lambda$  chosen by LOOCV is 0.001

2.with validation: train error:0.0 test error:

3.without validation: train error: 0.0 test error:0.0517

```
without regularization , train error: 0.0
without regularization , test error 0.05173279758915118
```

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```
the chosen lambda is: 0.001
train error with regularization 0.0
test error with regularization 0.050226017076845805
```

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### Problem 2-3. Bias Variance Trade-off

#### a) True or False

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