Answers of Homework 2

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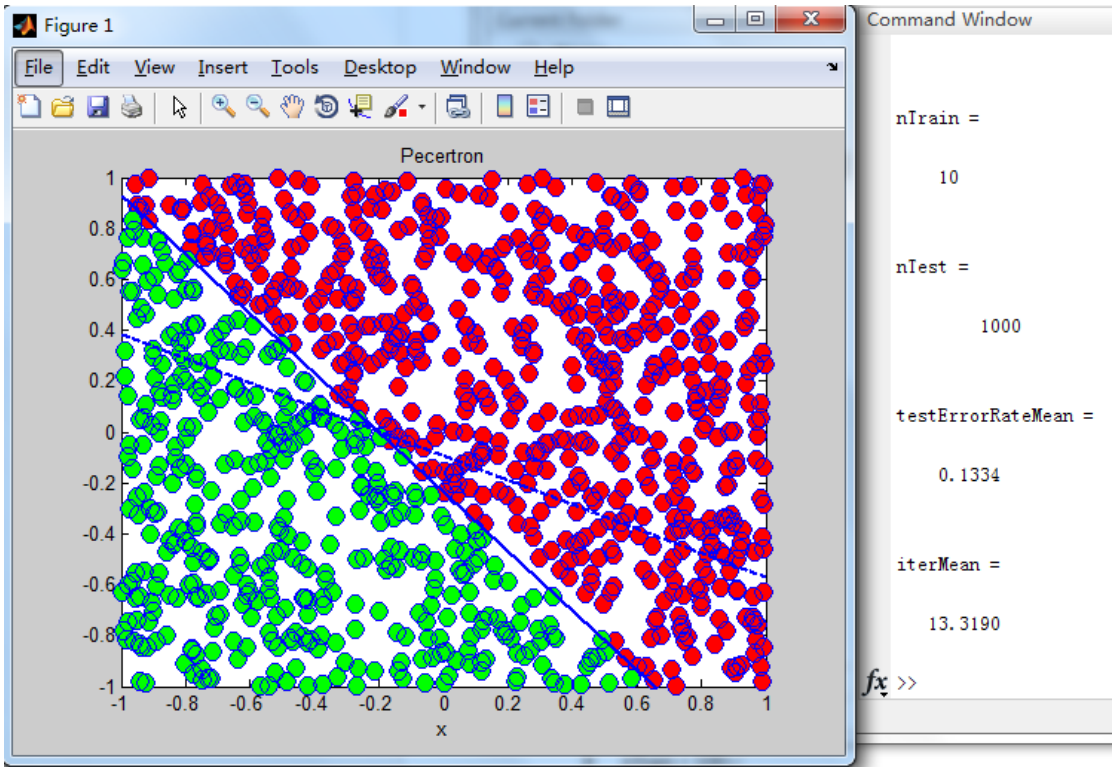
1. A Walk Through Linear Models

(a) Perceptron

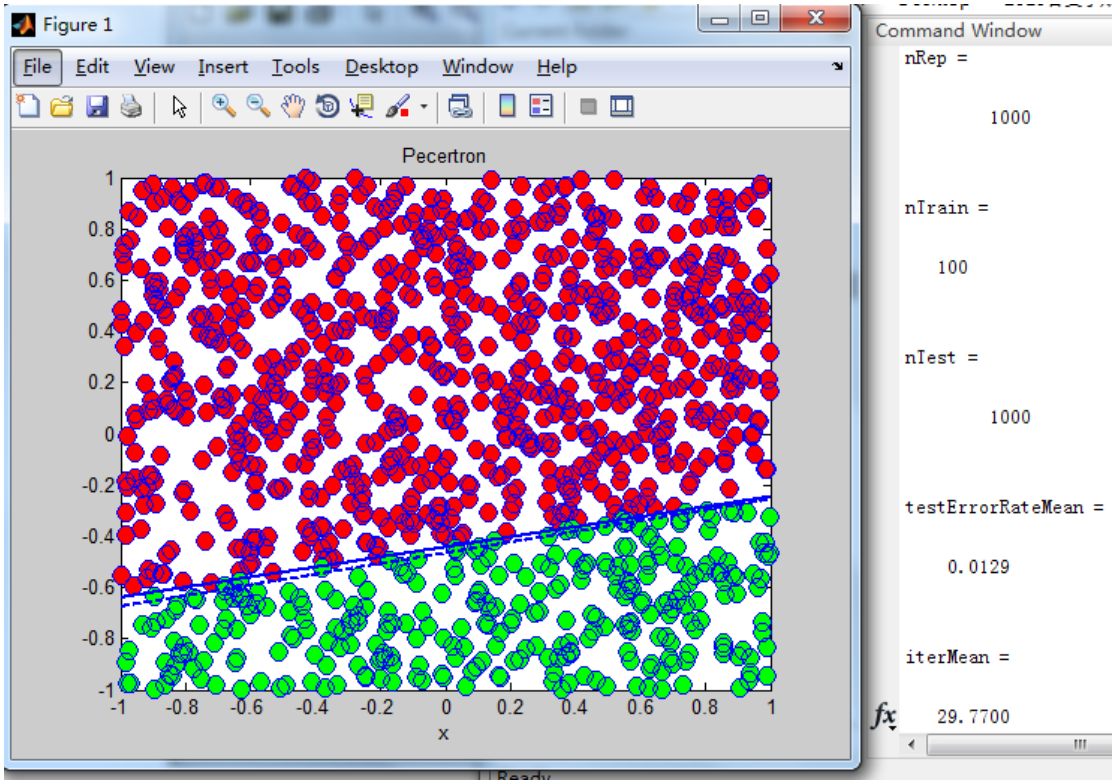
(i), (ii)

Note: The training error rates are all 0, because my perceptron algorithm only stops when all the training data are properly classified.

nTrain = 10 :



nTrain = 100:

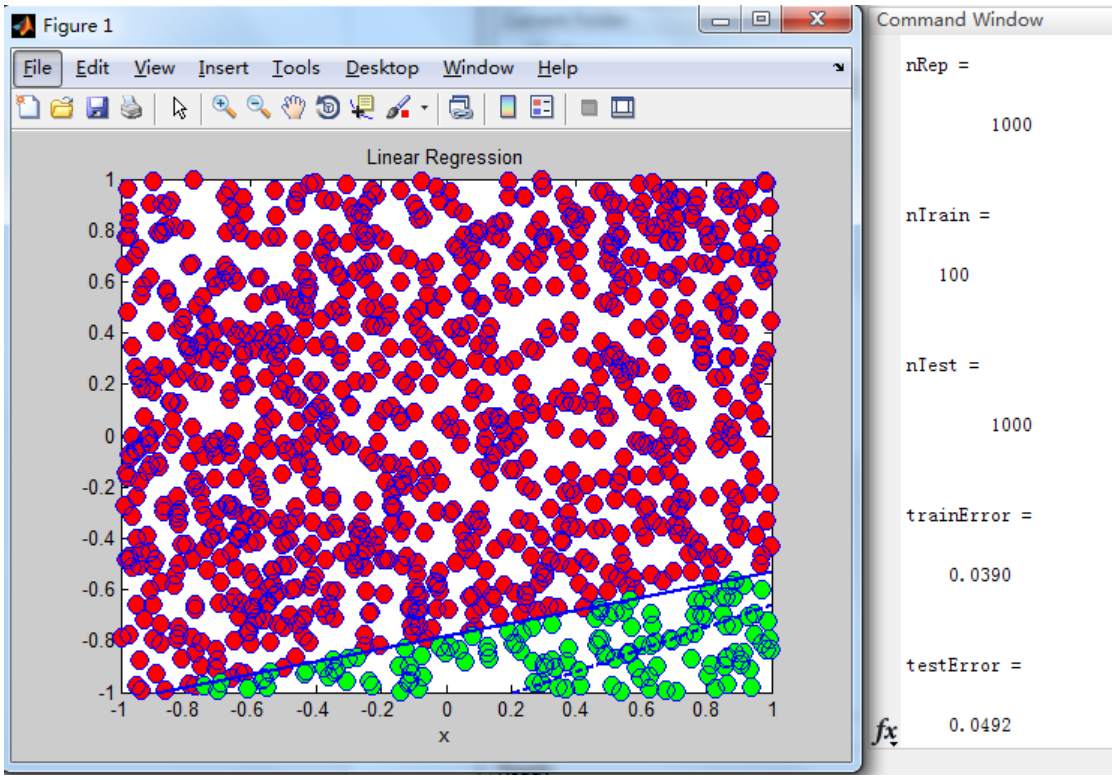


(iii)

Then my algorithm will never stop, because it cannot find a proper function to correctly classify all the training data points.

(b) Linear Regression

(i)



(ii)

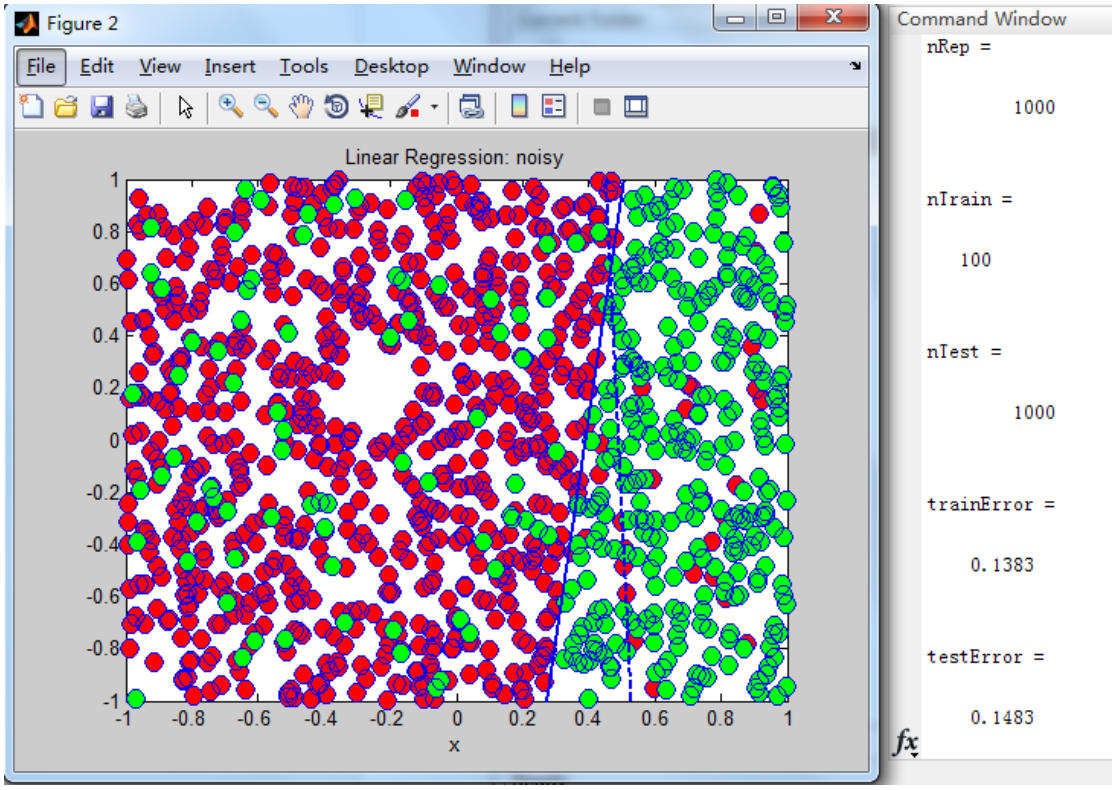


Figure 2
File Edit View Insert Tools Desktop Window Help
Linear Regression: noisy
x
Command Window
nRep =
1000
nIrain =
100
nIest =
1000
trainError =
0.1383
testError =
0.1483

(iii)

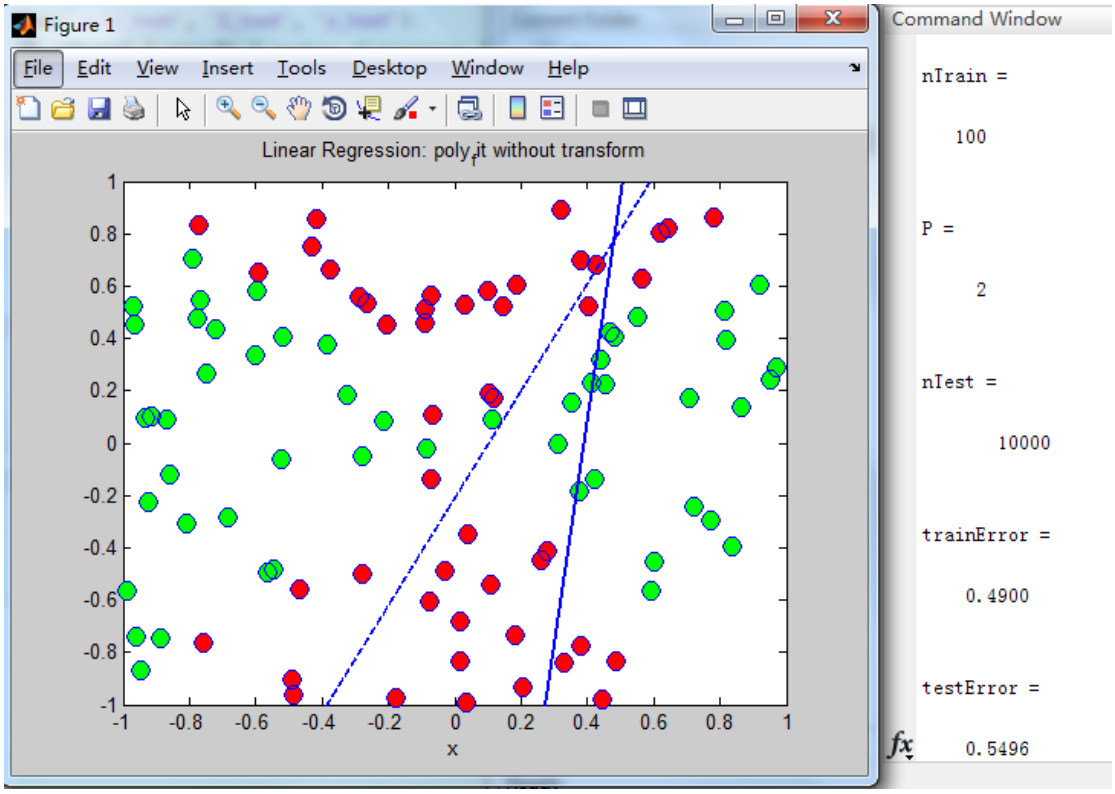
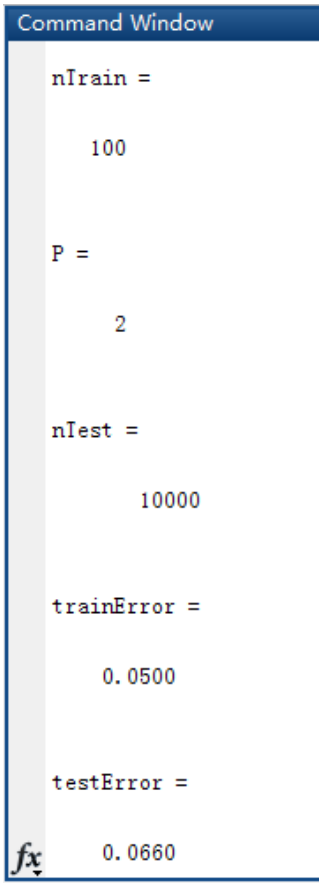


Figure 1
File Edit View Insert Tools Desktop Window Help
Linear Regression: poly fit without transform
x
Command Window
nIrain =
100
P =
2
nIest =
10000
trainError =
0.4900
testError =
0.5496

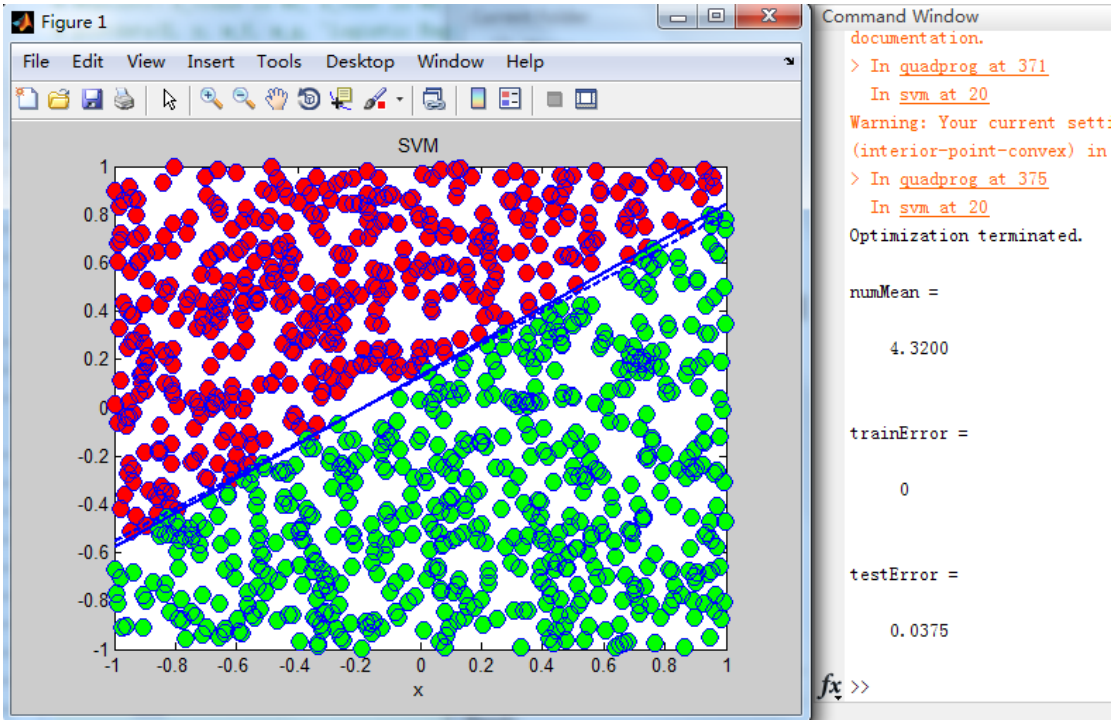
(iv)



(d) Support Vector Machine

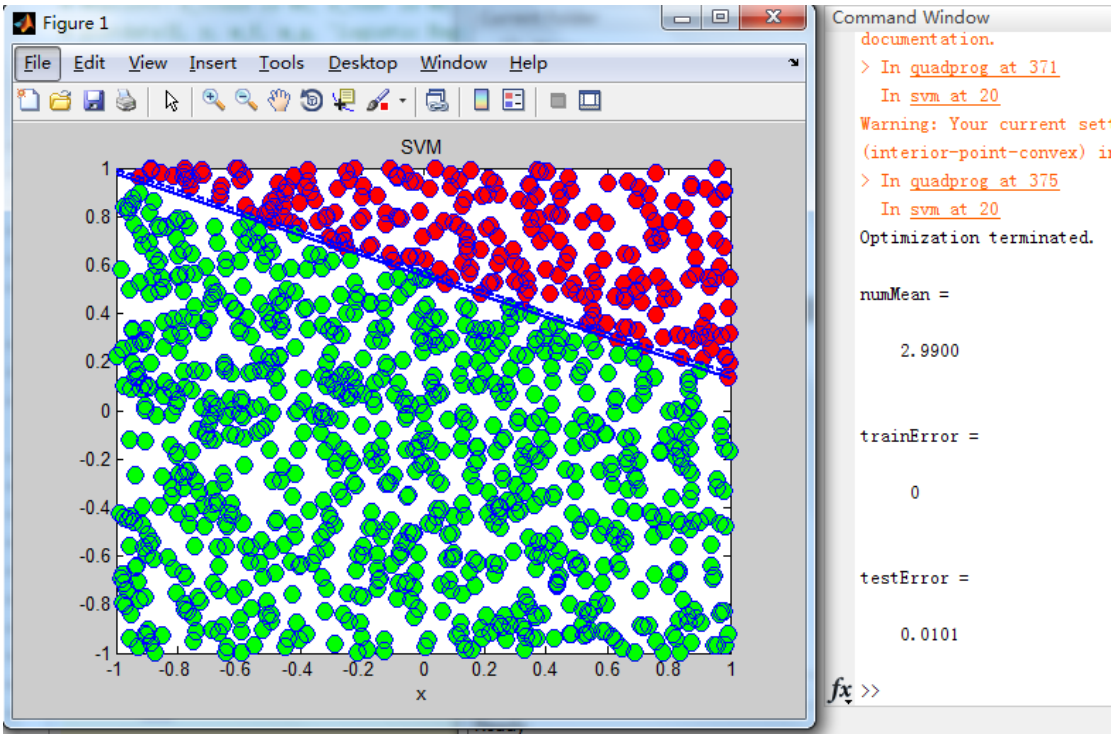
(i)

nTrain = 30



(ii), (iii)

nTrain = 100



2. Regularization and Cross-Validation

(a)

(i)

When lambdas = [1e-3, 1e-2, 1e-1, 0, 1, 1e1, 1e2, 1e3]:

```
valiError =

   1.0e+35 *

    0.0000    0.0000    0.0000    5.7656    0.0000    0.0000    0.0000    0.0000


lambda =

   100
```

We see that when lambda=0, the validation error is so huge that we can't see other error values clearly, so we run another one:

When lambdas = [1e-3, 1e-2, 1e-1, 1, 1e1, 1e2, 1e3]:

```
valiError =

  106.7238  106.6021  105.4160   96.0079   66.8670   46.4918   63.8291


lambda =

   100
```

So the lambda chosen by LOOCV is 100.

(ii), (iii)

Without regularization (lambda=0):

```
wIw0 =

   1.2213e+33

trainErrorRate0 =

    0.6750

testErrorRate0 =

    0.6087
```

With regularization (lambda=100):

```
wIw_chosen =

    0.1332

trainErrorRate =

     0

testErrorRate =

    0.0598
```

3. Bias Variance Trade-off

(a) True or False

(i) False. Add training examples will not make much change on the model we learn, so even with high bias, the test error won't improve significantly.
(ii) False. Sometimes will be overfitting. And reducing test error is more important than better fitting training set.
(iii) True.
(iv) False. It will performance worse on training set but it is useful to avoid overfitting

and to obtain a better model which can do better on testing set.
(v) False. Definitely it will hurt the hypothesis.

4. Neural Network vs. SVM

(a) Neural Network

```
Error rate for NN is 0.024800.
>>
```

(b) Multi-class SVM (libsvm version 1.94)

```
errorRate =

    0.1204
```