KAI YE-HW2

October 19, 2017

1 Problem1

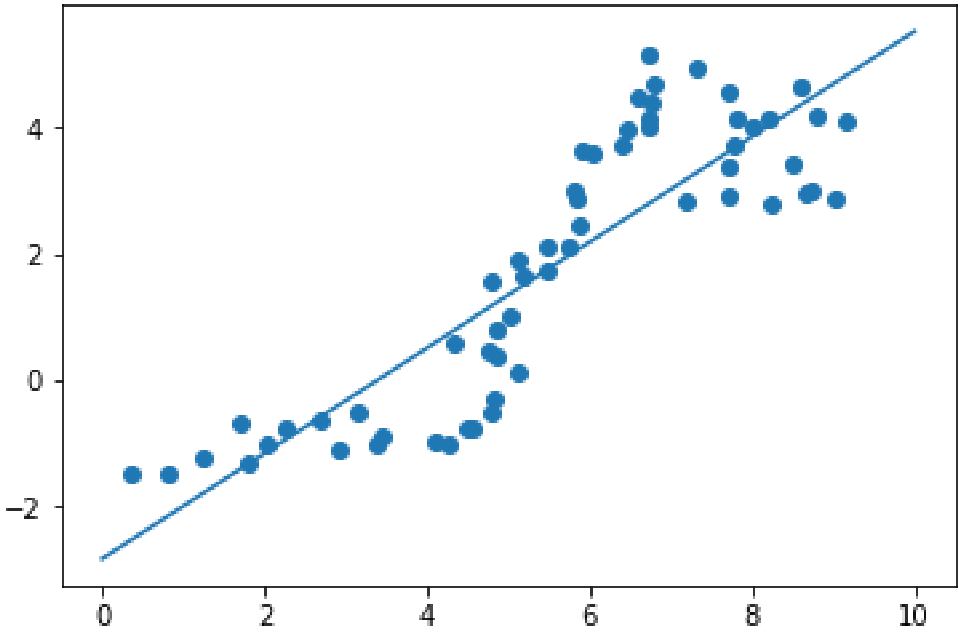
1.1

```
In [3]: import numpy as np
        import matplotlib.pyplot as plt
        import mltools as ml
        data=np.genfromtxt("data/curve80.txt",delimiter=None)
        X = data[:,0]
        X = np.atleast_2d(X).T
        Y = data[:,1]
        Xtr,Xte,Ytr,Yte = ml.splitData(X,Y,0.75)
        print(Xtr.shape)
        print(Xte.shape)
        print(Ytr.shape)
        print(Yte.shape)
```

```
(60, 1)
(20, 1)
(60,)
(20,)
```

1.2

```
In [99]: import numpy as np
         import matplotlib.pyplot as plt
         import mltools as ml
         data=np.genfromtxt("data/curve80.txt",delimiter=None)
         X = data[:,0]
         X = np.atleast_2d(X).T
         Y = data[:,1]
         Xtr,Xte,Ytr,Yte = ml.splitData(X,Y,0.75)
         lr = ml.linear.linearRegress( Xtr, Ytr )
         xs = np.linspace(0,10,200)
         xs = xs[:,np.newaxis]
         ys = lr.predict(xs)
         plt.scatter(Xtr,Ytr)
plt.plot(xs,ys)
plt.show()
print(lr.theta)
list=[1]
list=list*60
arr=np.array(list)
arr1=np.c_[np.array(arr),np.array(Xtr)]
YY=Ytr.reshape(60,1)
e = YY-arr1.dot(lr.theta.T)
J = e.T.dot( e )/60
print(J)
list=[1]
list=list*20
arr=np.array(list)
arr1=np.c_[np.array(arr),np.array(Xte)]
YY=Yte.reshape(20,1)
e = YY-arr1.dot(lr.theta.T)
J = e.T.dot( e )/20
print(J)
```



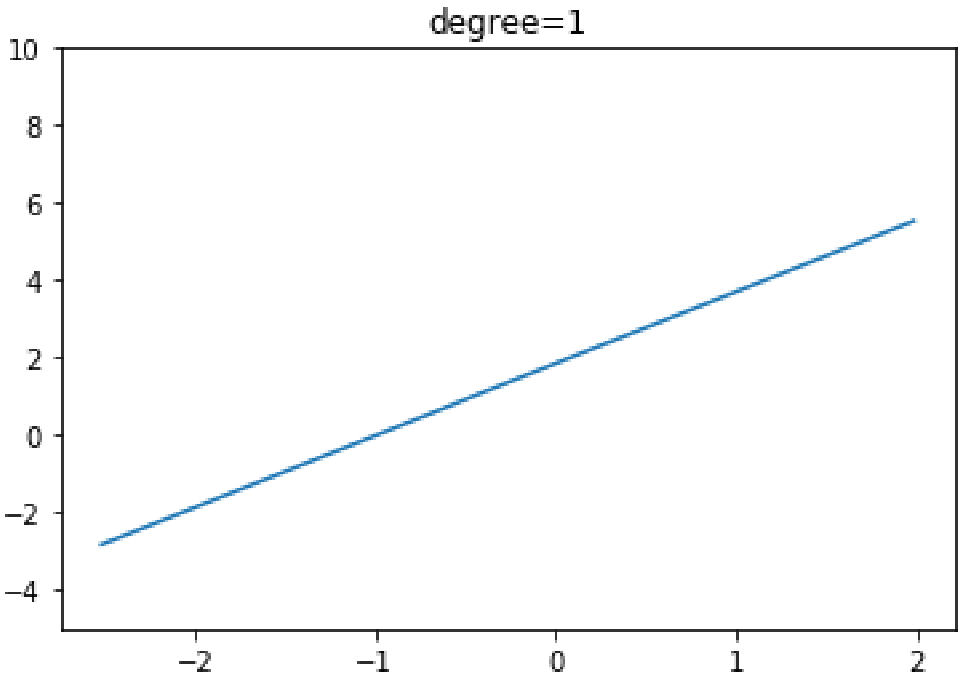
```
[[-2.82765049  0.83606916]]
[[ 1.12771196]]
[[ 2.2423492]]
```

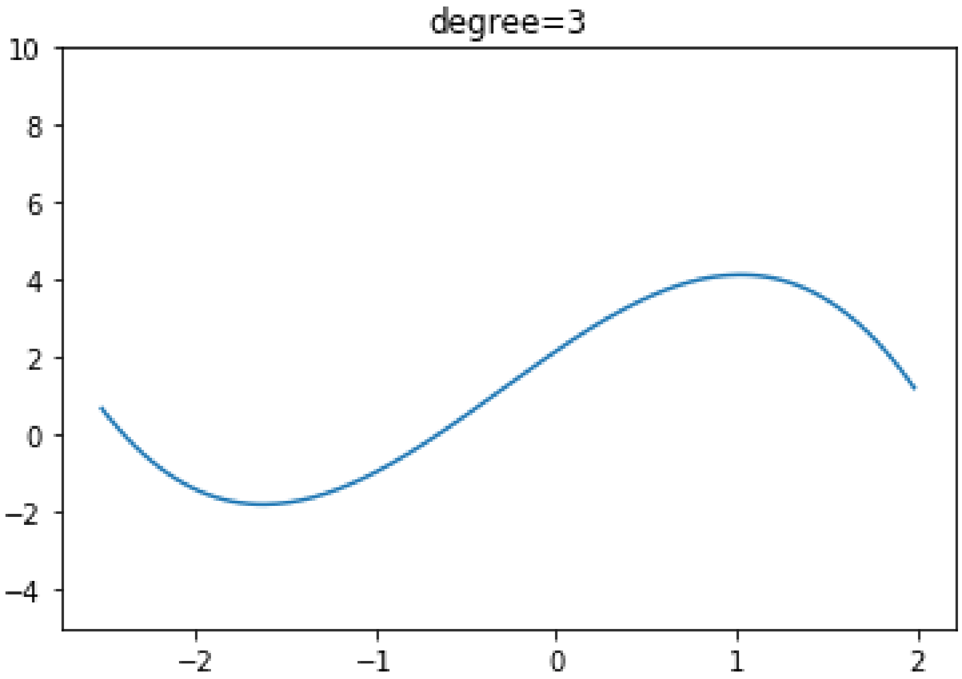
so from the above we can see lr.theta is [[-2.82765049 0.83606916]] which verify my plot

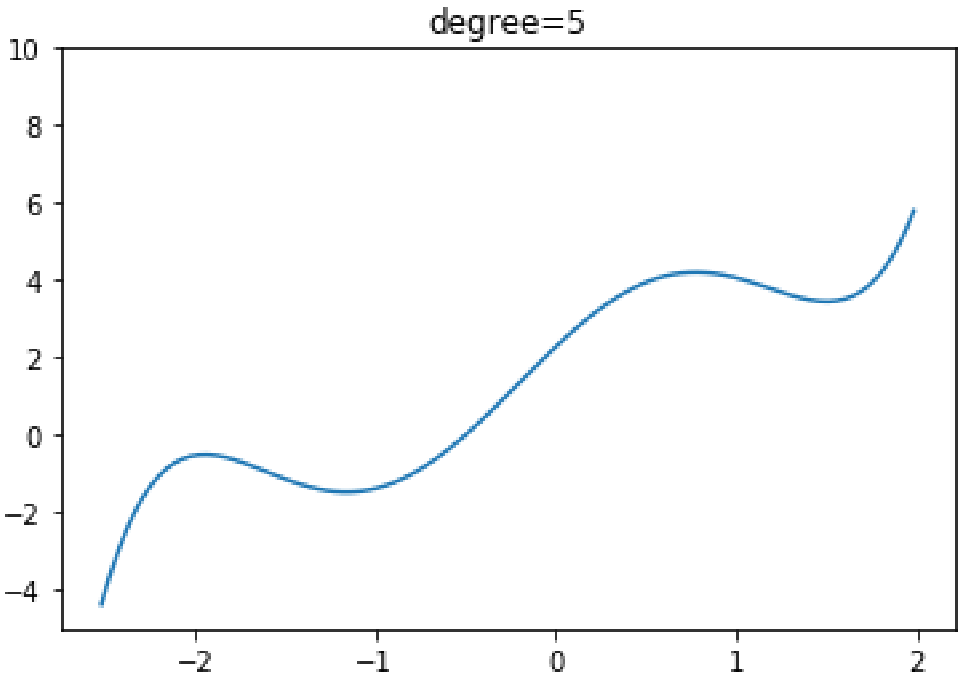
The mean squared error of the predictions on the training data is [[1.12771196]], on test data is [[2.2423492]]

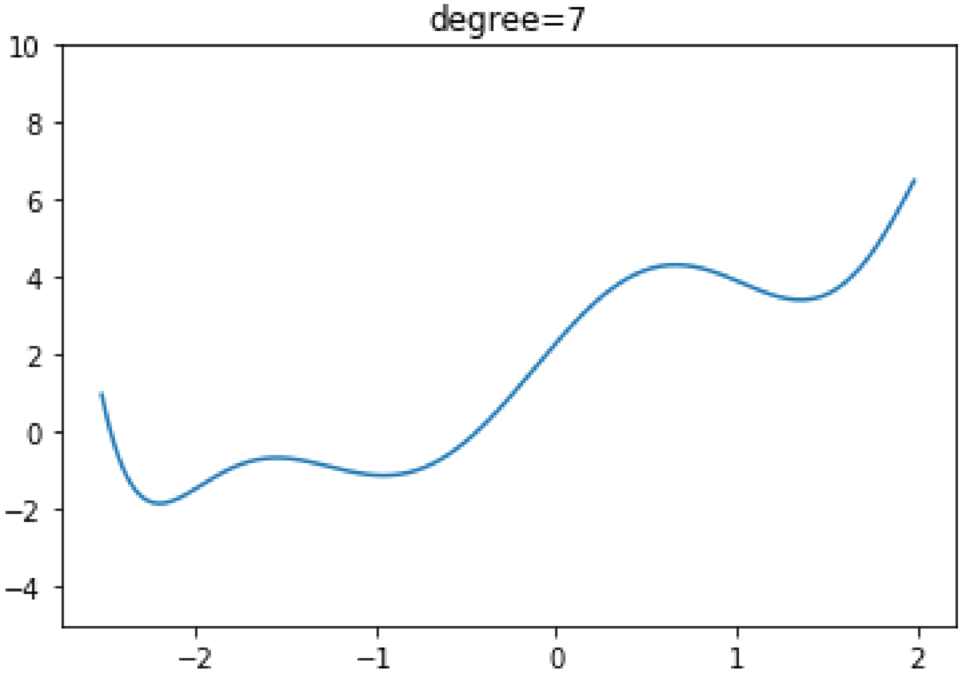
1.3

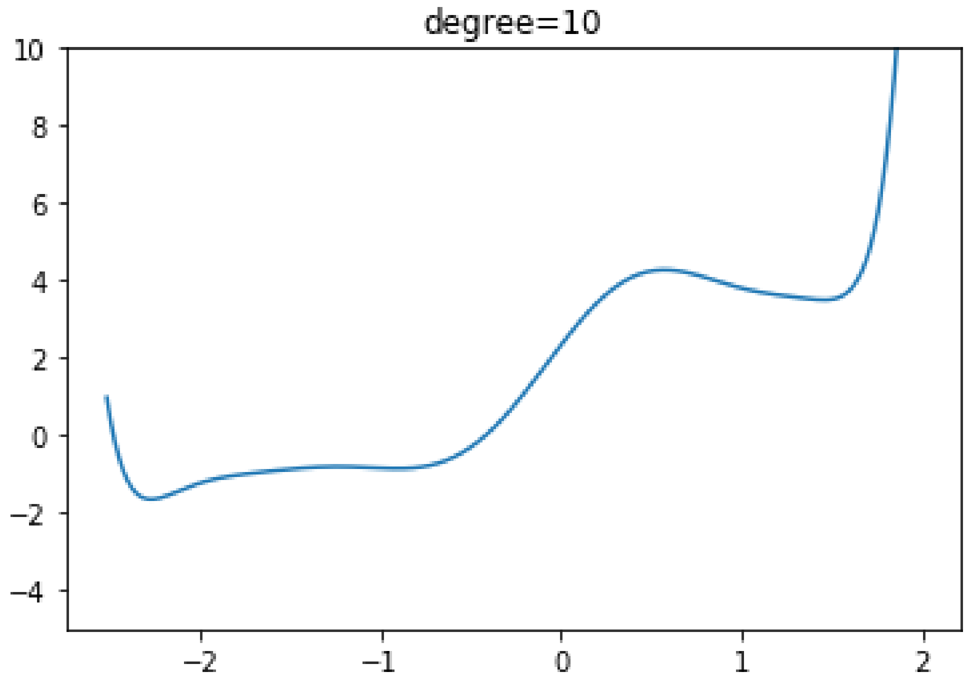
```
In [161]: import numpy as np
          import matplotlib.pyplot as plt
          import mltools as ml
          data=np.genfromtxt("data/curve80.txt",delimiter=None)
          set=[1,3,5,7,10,18]
          X = data[:,0]
          X = np.atleast_2d(X).T
          Y = data[:,1]
          Xtr,Xte,Ytr,Yte = ml.splitData(X,Y,0.75)
          #lt.figure()
          #ount=1
          for i in set:
              XtrP = ml.transforms.fpoly(Xtr, i, bias=False)
              XtrP,params = ml.transforms.rescale(XtrP)
              lr = ml.linear.linearRegress( XtrP, Ytr )
              XteP,_ = ml.transforms.rescale( ml.transforms.fpoly(Xte,i,bias=False), params)
              xs = np.linspace(0,10,200)
              xs = xs[:,np.newaxis]
              xs,_ = ml.transforms.rescale( ml.transforms.fpoly(xs,i,bias=False), params)
              ys = lr.predict(xs)
              #lt.subplot(3,2,count)
              #ount+=1
              plt.plot(xs[:,0],ys)
              plt.ylim(-5,10)
              plt.title("degree="+str(i))
              plt.show()
```

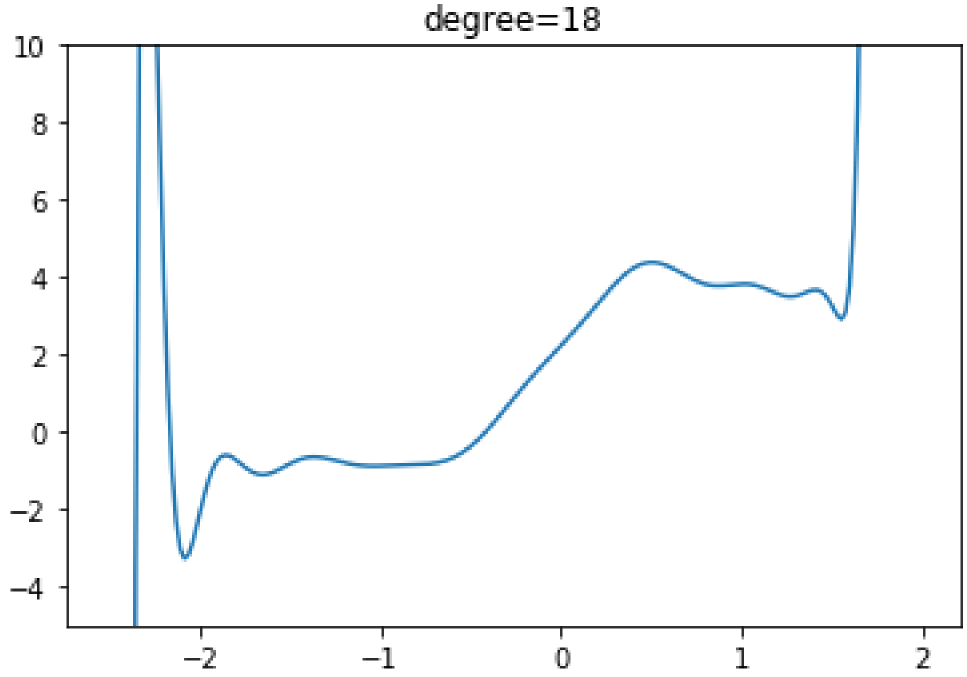

degree=1


degree=3


degree=5
10
8
6
4
2
0
−2
−4
−2
−1
0
1
2

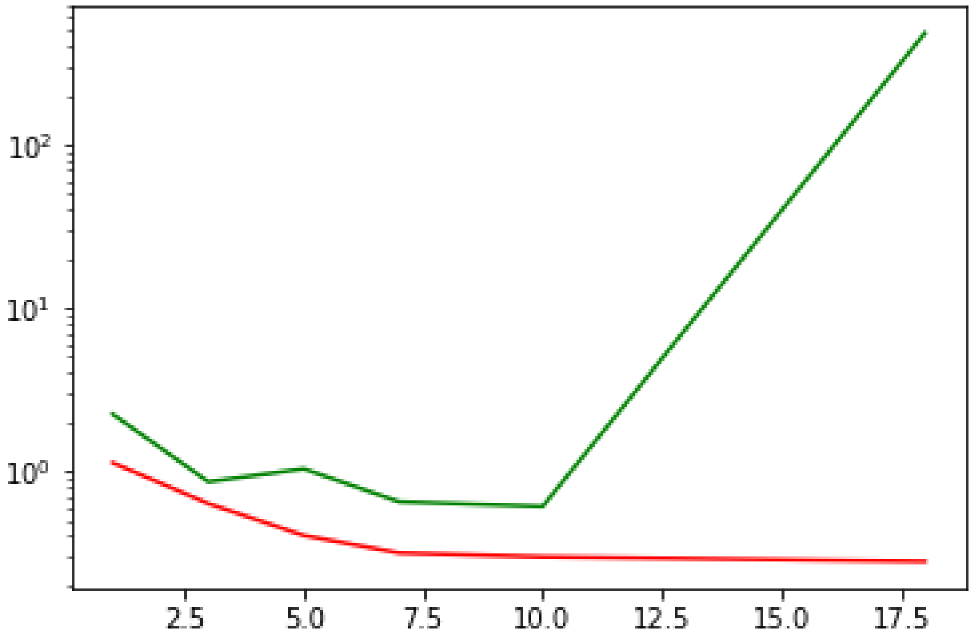

degree=7
10
8
6
4
2
0
−2
−4
−2
−1
0
1
2





learned functions are above, corresponding to 6 degrees.

```
In [119]: import numpy as np
          import matplotlib.pyplot as plt
          import mltools as ml
          data=np.genfromtxt("data/curve80.txt",delimiter=None)
          set=[1,3,5,7,10,18]
          X = data[:,0]
          X = np.atleast_2d(X).T
          Y = data[:,1]
          Xtr,Xte,Ytr,Yte = ml.splitData(X,Y,0.75)
          Jtr=[0,0,0,0,0,0]
          Jte=[0,0,0,0,0,0]
          for j,i in enumerate(set):
              XtrP = ml.transforms.fpoly(Xtr, i, bias=False)
              XtrP,params = ml.transforms.rescale(XtrP)
              lr = ml.linear.linearRegress( XtrP, Ytr )
              XteP,_ = ml.transforms.rescale( ml.transforms.fpoly(Xte,i,bias=False), params)
              Ytrp=lr.predict(XtrP)
              Ytep=lr.predict(XteP)
              list=[1]
              list=list*60
              arr=np.array(list)
              arr1=np.c_[np.array(arr),np.array(XtrP)]
              YY=Ytr.reshape(60,1)
              e = YY-arr1.dot(lr.theta.T)
              Jtr[j] = e.T.dot( e )/60
              list=[1]
              list=list*20
              arr=np.array(list)
              arr1=np.c_[np.array(arr),np.array(XteP)]
              YY=Yte.reshape(20,1)
              e = YY-arr1.dot(lr.theta.T)
              Jte[j] = e.T.dot( e )/20
          arr1=[0,0,0,0,0,0]
          arr2=[0,0,0,0,0,0]
          for l,k in enumerate(Jtr):
              arr1[l]=k[0][0]
          for l,k in enumerate(Jte):
              arr2[l]=k[0][0]
          plt.semilogy(set,arr1,'r')
          plt.semilogy(set,arr2,'g')
          plt.show()
          print(arr2)
```



```
[2.2423492030101251, 0.86161148154499967, 1.0344190205632322, 0.65022460796711801, 0.6090600748
```

(c). 10. 10 degree is best because green line has its lowest MSE there.

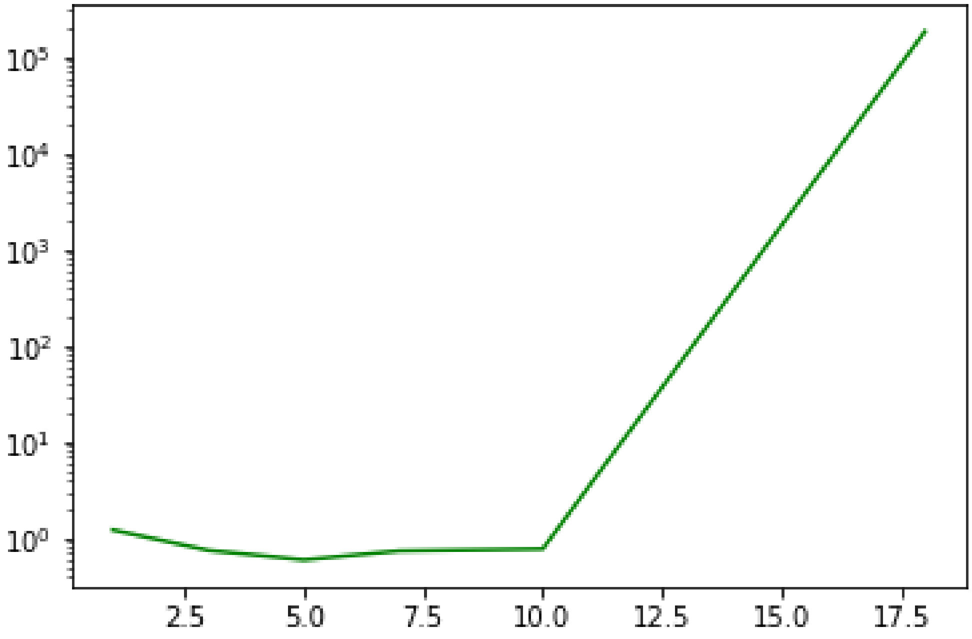
2 Problem2

2.1

```
In [143]: import numpy as np
          import matplotlib.pyplot as plt
          import mltools as ml
          data=np.genfromtxt("data/curve80.txt",delimiter=None)
          set=[1,3,5,7,10,18]
          X = data[:,0]
          X = np.atleast_2d(X).T
          Y = data[:,1]
          Xtr,Xte,Ytr,Yte = ml.splitData(X,Y,0.75)
          J=[0,0,0,0,0]
          crossval=[0,0,0,0,0,0]
          nFolds = 5;

          for j,i in enumerate(set):
              for iFold in range(nFolds):
                  XtrP = ml.transforms.fpoly(Xtr, i, bias=False)
```

```
        XtrP,params = ml.transforms.rescale(XtrP)
        Xti,Xvi,Yti,Yvi = ml.crossValidate(XtrP,Ytr,nFolds,iFold)
        learner = ml.linear.linearRegress(Xti,Yti)
        list=[1]
        list=list*12
        arr=np.array(list)
        arr1=np.c_[np.array(arr),np.array(Xvi)]
        YY=Yvi.reshape(12,1)
        e = YY-arr1.dot(learner.theta.T)
        J[iFold] =e.T.dot( e )/12
    crossval[j]=np.mean(J)
plt.semilogy(set,crossval,'g')
plt.show()
print(crossval)
```



```
[1.2118626629641986, 0.7429005752051665, 0.59107037264069906, 0.73356378313114556, 0.7677056689
```

2.2

using print(crossval),we know the values of cross-validation MSEs. Compared to the test data MSEs,

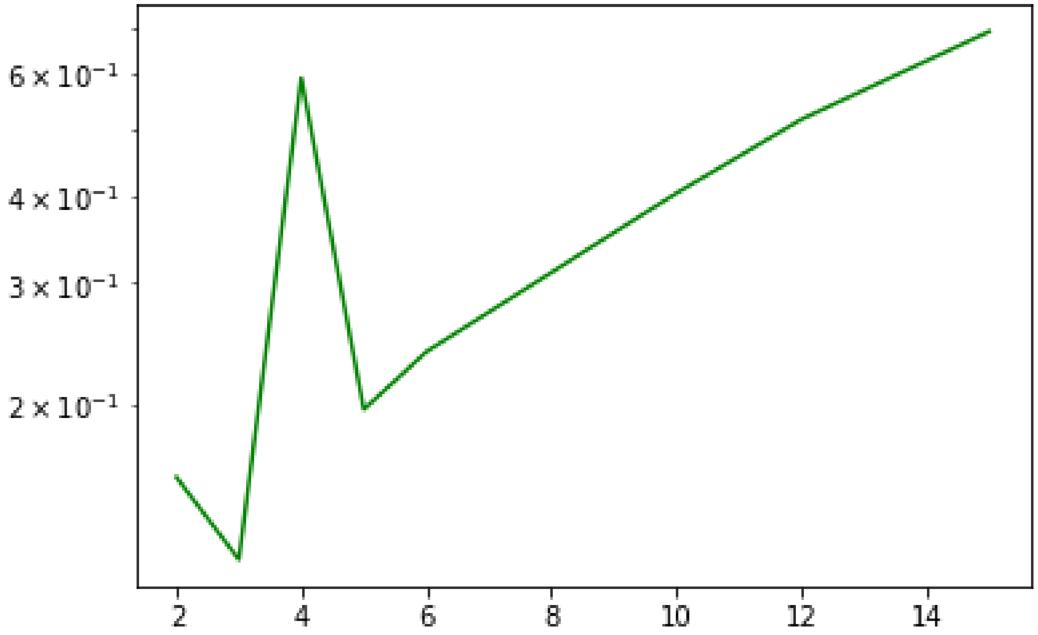
we see that when degree=1,3,5, the MSEs of cross-validation are smaller than test data MSEs. But when degree=7,10,18, the MSEs of cross-validation are bigger than test data MSEs.

2.3

I recommand degree 5 because it has the lowest MSE.

2.4

```
In [145]: import numpy as np
          import matplotlib.pyplot as plt
          import mltools as ml
          data=np.genfromtxt("data/curve80.txt",delimiter=None)
          nFolds=[2,3,4,5,6,10,12,15]
          X = data[:,0]
          X = np.atleast_2d(X).T
          Y = data[:,1]
          Xtr,Xte,Ytr,Yte = ml.splitData(X,Y,0.75)
          J=[0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]
          crossval=[0,0,0,0,0,0,0,0]
          j=0
          for p,iFold in enumerate(nFolds):
              for i in range(iFold):
                  XtrP = ml.transforms.fpoly(Xtr, 5, bias=False)
                  XtrP,params = ml.transforms.rescale(XtrP)
                  Xti,Xvi,Yti,Yvi = ml.crossValidate(XtrP,Ytr,iFold,i)
                  learner = ml.linear.linearRegress(Xti,Yti)
                  num=int(60/iFold)
                  list=[1]
                  list=list*num
                  arr=np.array(list)
                  arr1=np.c_[np.array(arr),np.array(Xvi)]
                  YY=Yvi.reshape(num,1)
                  e = YY-arr1.dot(learner.theta.T)
                  J[i] =e.T.dot( e )/num
              crossval[j]=np.mean(J)
              j+=1
          plt.semilogy(nFolds,crossval,'g')
          plt.show()
```



When nFolds number is 2, the number of trian data is equal to validation data.

When number becomes 3, it have a lowest MSE.But when it becomes 4, the number of training data is 3 times

of validation data, which makes error increased. And when the number becomes 5 and larger, the number of

validation data becomes smaller and smaller, which made the MSEs increase steadily.

3 Statement of Collaboration

No disscuss with others