ProjectStartUp1_NeuralNetwork-M2

December 12, 2020

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```python
[4]: from scipy.io import loadmat
     import numpy as np

     #SETUP
     X = loadmat("RawData.mat")['X']
     y = loadmat("RawData.mat")['y']
     Xones = np.ones((len(X),1))

     #Single threshold for classification
     thresh = 1500
     for i in range(len(X)):
         if(y[i] <= thresh):
             y[i] = 0
         if(y[i] > thresh):
             y[i] = 1

     #print(np.mean(y))

     #Optional: Eliminate high values
     #for i in range(110):
     #    X = np.delete(X, np.argmax(y), 0)
     #    y = np.delete(y, np.argmax(y), 0)
     #    X = np.delete(X, np.argmin(y), 0)
     #    y = np.delete(y, np.argmin(y), 0)

     TwoNormCol = np.zeros((len(X.T),1))

     #Remove keyword columns (poorly treated data)
     X = np.delete(X, 17, 1)
     X = np.delete(X, 17, 1)
     X = np.delete(X, 17, 1)
     X = np.delete(X, 17, 1)
     X = np.delete(X, 17, 1)
     X = np.delete(X, 17, 1)
     X = np.delete(X, 17, 1)
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```python
X = np.delete(X, 17, 1)
X = np.delete(X, 17, 1)

#Normalize columns to 2-norm
for i in range(len(X.T)):
    TwoNormCol[i] = np.sqrt(X[i,:]@X[i,:])
    X[i,:] = X[i,:]/TwoNormCol[i]
#print(TwoNormCol)
#print(X[0,:])
#print(y)

#Form subsets (indices, first group is full X)
Xsubs = np.
 →array([[0,49],[0,5],[5,7],[7,9],[9,11],[11,17],[17,20],[20,26],[28,33],[33,37],[37,45],[45,

#Create and run over 11 sets of 3604 entries from X and y,
#using 1 as a primary test set (when needed for lambda)
setArr = np.array([[0,int(len(X)/11)],[int(len(X)/11),int(2*len(X)/
 →11)],[int(2*len(X)/11),int(3*len(X)/11)],\
                  [int(3*len(X)/11),int(4*len(X)/11)],[int(4*len(X)/
 →11),int(5*len(X)/11)],\
                  [int(5*len(X)/11),int(6*len(X)/11)],[int(6*len(X)/
 →11),int(7*len(X)/11)],\
                  [int(7*len(X)/11),int(8*len(X)/11)],[int(8*len(X)/
 →11),int(9*len(X)/11)],\
                  [int(9*len(X)/11),int(10*len(X)/11)],[int(10*len(X)/
 →11),int(len(X))]])
#print(setArr)

#Set up network node count
networkCount = 3
networkTest = np.linspace(2, 6, networkCount)
#print(networkCount)

#Error tally storage
errorOrig = np.zeros((110,1))


##############################

#Only looping over full X matrix
Xset = 0

M = 2

errorOrig = np.zeros((12,1))
```

```python
errorNew = np.zeros((12,1))

for Xset in range(len(Xsubs)):
    for i in range(11):
        print("X subset = ",Xset,", i = ",i)
        testTally = 0
        #Set up Training and testing sets
        for k in range(11):
            if i == k:
                XTest1 = X[setArr[i,0]:setArr[i,1],Xsubs[Xset,0]:Xsubs[Xset,1]]
                #print(XTest1)
                yTest1 = y[setArr[i,0]:setArr[i,1]]
                #print(yTest1)
            if k != i:
                if testTally == 0:
                    XTrain = X[setArr[k,0]:setArr[k,1],Xsubs[Xset,0]:
→Xsubs[Xset,1]]

                    yTrain = y[setArr[k,0]:setArr[k,1]]
                    testTally = 1
                else:
                    XTrain = np.concatenate((XTrain, X[setArr[k,0]:
→setArr[k,1],Xsubs[Xset,0]:Xsubs[Xset,1]]),\
                                            axis=0)
                    yTrain = np.concatenate((yTrain, y[setArr[k,0]:
→setArr[k,1]]), axis=0)

        XTest1 = np.hstack((np.ones((len(XTest1),1)), XTest1))
        XTrain = np.hstack((np.ones((len(XTrain),1)), XTrain))

        # Storage for current iteration
        #WNET = np.zeros((len(X.T),networkCount))

        # Loop through different counts
        #for index in range(networkCount):
            #M = networkTest[index]

        V = np.random.randn(M+1, 1);
        W = np.random.randn(len(XTrain.T), M);

        #Step and epoch count
        alpha = 0.5
        L = 10

        def logsig(_x):
            return 1/(1+np.exp(-_x))

        for epoch in range(L):
```

```python
        ind = np.random.permutation(len(XTrain))
        for iii in ind:
            # Forward propagation
            H = logsig(np.hstack((np.ones((1,1)), XTrain[[iii],:]@W)))
            #print(np.hstack((np.ones((1,1)), XTrain[[iii],:]@W)))
            Yhat = logsig(H@V)

            # Back propagation
            delta = (Yhat-yTrain[[iii]])*Yhat*(1-Yhat)
            Vnew = V-alpha*H.T@delta
            gamma = delta@V[1:,:].T*H[:,1:]*(1-H[:,1:])
            Wnew = W - alpha*XTrain[[iii],:].T@gamma
            #print(alpha*XTrain[[iii],:].T@gamma)
            V = Vnew
            W = Wnew
        print(epoch)


    H = logsig(np.hstack((np.ones((len(XTrain),1)), XTrain@W)))
    y_net1 = logsig(H@V)

    errorOrigTemp = 0
    for index in range(len(XTrain)):
        if (yTrain[index] > 0.5 and y_net1[index] < 0.5) or (yTrain[index]␣
↪< 0.5 and y_net1[index] > 0.5):
            errorOrigTemp = errorOrigTemp + 1
    errorOrigTemp = errorOrigTemp/len(XTrain)
    print("Mean error with orig set: ",errorOrigTemp)

    H = logsig(np.hstack((np.ones((len(XTest1),1)), XTest1@W)))
    y_net1 = logsig(H@V)

    errorOrig[Xset] = errorOrig[Xset] + errorOrigTemp

    errorOrigTemp = 0
    for index in range(len(XTest1)):
        if (yTest1[index] > 0.5 and y_net1[index] < 0.5) or (yTest1[index]␣
↪< 0.5 and y_net1[index] > 0.5):
            errorOrigTemp = errorOrigTemp + 1
    errorOrigTemp = errorOrigTemp/len(yTest1)
    print("Mean error with test set: ",errorOrigTemp)

    errorNew[Xset] = errorNew[Xset] + errorOrigTemp



GlobalMeanOrigError = np.zeros((11,1))
```

```python
GlobalMeanNewError = np.zeros((11,1))
for index in range(11):
    GlobalMeanOrigError[index] = errorOrig[index]/11
    GlobalMeanNewError[index] = errorNew[index]/11
    print("Mean Error for training set, X subset ",(index+1)," =␣
 ↪",GlobalMeanOrigError[index])
    print("Mean Error for test set, X subset ",(index+1)," =␣
 ↪",GlobalMeanNewError[index])
```

X subset = 0 , i = 0

/opt/conda/lib/python3.7/site-packages/ipykernel_launcher.py:117:
RuntimeWarning: overflow encountered in exp

0
1
2
3
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6
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8
9
Mean error with orig set: 0.5443118756936737
Mean error with test set: 0.4961154273029967
X subset = 0 , i = 1
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4514428412874584
Mean error with test set: 0.5463374028856826
X subset = 0 , i = 2
0
1
2
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6
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9
Mean error with orig set:  0.465788013318535
Mean error with test set:  0.40288568257491675
X subset =  0 , i =  3
0
1
2
3
4
5
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9
Mean error with orig set:  0.463984461709212
Mean error with test set:  0.41509433962264153
X subset =  0 , i =  4
0
1
2
3
4
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6
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8
9
Mean error with orig set:  0.4596281908990011
Mean error with test set:  0.46448390677025525
X subset =  0 , i =  5
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4554661487236404
Mean error with test set:  0.5061043285238623
X subset =  0 , i =  6
0
1
```

2
3
4
5
6
7
8
9
Mean error with orig set: 0.45493895671476137
Mean error with test set: 0.4961154273029967
X subset = 0 , i = 7
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.45835183129855717
Mean error with test set: 0.46420643729189787
X subset = 0 , i = 8
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.46090455049944506
Mean error with test set: 0.4514428412874584
X subset = 0 , i = 9
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.5125416204217536

```
Mean error with test set:  0.5768590455049944
X subset =  0 , i =  10
0
1
2
3
4
5
6
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9
Mean error with orig set:  0.465788013318535
Mean error with test set:  0.3920643729189789
X subset =  1 , i =  0
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4547169811320755
Mean error with test set:  0.5033296337402886
X subset =  1 , i =  1
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.548196448390677
Mean error with test set:  0.45366259711431745
X subset =  1 , i =  2
0
1
2
3
4
5
6
```

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9
Mean error with orig set: 0.5339067702552719
Mean error with test set: 0.5971143174250833
X subset = 1 , i = 3
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4646503884572697
Mean error with test set: 0.4142619311875694
X subset = 1 , i = 4
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.45810210876803553
Mean error with test set: 0.46614872364039955
X subset = 1 , i = 5
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.5442008879023308
Mean error with test set: 0.4938956714761376
X subset = 1 , i = 6
0
1
2

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3
4
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9
Mean error with orig set:  0.4551054384017758
Mean error with test set:  0.4961154273029967
X subset =  1 , i =  7
0
1
2
3
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5
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8
9
Mean error with orig set:  0.4596281908990011
Mean error with test set:  0.46448390677025525
X subset =  1 , i =  8
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4609322974472808
Mean error with test set:  0.4514428412874584
X subset =  1 , i =  9
0
1
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4
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6
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9
Mean error with orig set:  0.4630965593784684
Mean error with test set:  0.416204217536071
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```
X subset =  1 , i =  10
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1
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3
4
5
6
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9
Mean error with orig set:  0.46567702552719203
Mean error with test set:  0.39039955604883464
X subset =  2 , i =  0
0
1
2
3
4
5
6
7
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9
Mean error with orig set:  0.455188679245283
Mean error with test set:  0.5044395116537181
X subset =  2 , i =  1
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.45158157602663707
Mean error with test set:  0.5427302996670367
X subset =  2 , i =  2
0
1
2
3
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9
Mean error with orig set: 0.46570477247502773
Mean error with test set: 0.40149833518312983
X subset = 2 , i =   3
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9
Mean error with orig set: 0.4646503884572697
Mean error with test set: 0.4142619311875694
X subset = 2 , i =   4
0
1
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5
6
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9
Mean error with orig set: 0.45929522752497226
Mean error with test set: 0.46587125416204217
X subset = 2 , i =   5
0
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6
7
8
9
Mean error with orig set: 0.5321864594894562
Mean error with test set: 0.4955604883462819
X subset = 2 , i =   6
0
1
2
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4
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9
Mean error with orig set: 0.4562430632630411
Mean error with test set: 0.4983351831298557
X subset = 2 , i = 7
0
1
2
3
4
5
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9
Mean error with orig set: 0.4588235294117647
Mean error with test set: 0.46781354051054386
X subset = 2 , i = 8
0
1
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9
Mean error with orig set: 0.5299667036625971
Mean error with test set: 0.5177580466148723
X subset = 2 , i = 9
0
1
2
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Mean error with orig set: 0.46387347391786904
Mean error with test set: 0.41759156492785793
X subset = 2 , i = 10

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Mean error with orig set:  0.4656492785793563
Mean error with test set:  0.40427302996670367
X subset =  3 , i =  0
0
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2
3
4
5
6
7
8
9
Mean error with orig set:  0.43385127635960047
Mean error with test set:  0.4841842397336293
X subset =  3 , i =  1
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.45069367369589347
Mean error with test set:  0.505826859045505
X subset =  3 , i =  2
0
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2
3
4
5
6
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9
Mean error with orig set:  0.5303274139844617
Mean error with test set:  0.5735294117647058
X subset =  3 , i =  3
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4411764705882353
Mean error with test set:  0.4306326304106548
X subset =  3 , i =  4
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4363762486126526
Mean error with test set:  0.4531076581576027
X subset =  3 , i =  5
0
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2
3
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9
Mean error with orig set:  0.4353218645948946
Mean error with test set:  0.4531076581576027
X subset =  3 , i =  6
0
1
2
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9
Mean error with orig set:  0.437819089900111
Mean error with test set:  0.4386792452830189
X subset =  3 , i =  7
0
1
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9
Mean error with orig set:  0.4596281908990011
Mean error with test set:  0.46448390677025525
X subset =  3 , i =  8
0
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Mean error with orig set:  0.4609322974472808
Mean error with test set:  0.4514428412874584
X subset =  3 , i =  9
0
1
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9
Mean error with orig set:  0.4656492785793563
Mean error with test set:  0.40427302996670367
X subset =  3 , i =  10
0
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Mean error with orig set:  0.45835183129855717
Mean error with test set:  0.4869589345172031
X subset =  4 , i =  0
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.5443118756936737
Mean error with test set:  0.49250832408435075
X subset =  4 , i =  1
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4514428412874584
Mean error with test set:  0.5463374028856826
X subset =  4 , i =  2
0
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```
Mean error with orig set:  0.465788013318535
Mean error with test set:  0.40288568257491675
X subset =  4 , i =  3
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.5349611542730299
Mean error with test set:  0.5857380688124306
X subset =  4 , i =  4
0
1
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9
Mean error with orig set:  0.4596281908990011
Mean error with test set:  0.46448390677025525
X subset =  4 , i =  5
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4554661487236404
Mean error with test set:  0.5061043285238623
X subset =  4 , i =  6
0
1
2
3
4
5
```

```
6
7
8
9
Mean error with orig set:  0.4551054384017758
Mean error with test set:  0.4961154273029967
X subset =  4 , i =  7
0
1
2
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6
7
8
9
Mean error with orig set:  0.4596281908990011
Mean error with test set:  0.46448390677025525
X subset =  4 , i =  8
0
1
2
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4
5
6
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8
9
Mean error with orig set:  0.4609322974472808
Mean error with test set:  0.4514428412874584
X subset =  4 , i =  9
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4656492785793563
Mean error with test set:  0.40427302996670367
X subset =  4 , i =  10
0
1
```

```
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4656492785793563
Mean error with test set:  0.40427302996670367
X subset =  5 , i =  0
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.40643729189789124
Mean error with test set:  0.4586570477247503
X subset =  5 , i =  1
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.38931742508324085
Mean error with test set:  0.4098224195338513
X subset =  5 , i =  2
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.38903995560488347
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```
Mean error with test set:  0.4125971143174251
X subset =  5 , i =  3
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.3891509433962264
Mean error with test set:  0.41148723640399554
X subset =  5 , i =  4
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4147058823529412
Mean error with test set:  0.4209211986681465
X subset =  5 , i =  5
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.3929800221975583
Mean error with test set:  0.4181465038845727
X subset =  5 , i =  6
0
1
2
3
4
5
6
```

7

8

9

Mean error with orig set: 0.3924250832408435

Mean error with test set: 0.3787458379578246

X subset = 5 , i = 7

0

1

2

3

4

5

6

7

8

9

Mean error with orig set: 0.39367369589345175

Mean error with test set: 0.3662597114317425

X subset = 5 , i = 8

0

1

2

3

4

5

6

7

8

9

Mean error with orig set: 0.41695338512763597

Mean error with test set: 0.39844617092119866

X subset = 5 , i = 9

0

1

2

3

4

5

6

7

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Mean error with orig set: 0.41145948945615984

Mean error with test set: 0.3634850166481687

X subset = 5 , i = 10

0

1

2

3
4
5
6
7
8
9
Mean error with orig set: 0.3949778024417314
Mean error with test set: 0.35321864594894564
X subset = 6 , i = 0
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4556881243063263
Mean error with test set: 0.5038845726970034
X subset = 6 , i = 1
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4514428412874584
Mean error with test set: 0.5463374028856826
X subset = 6 , i = 2
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.465788013318535
Mean error with test set: 0.40288568257491675

```
X subset =  6 , i =  3
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.5180632630410655
Mean error with test set:  0.5324639289678136
X subset =  6 , i =  4
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4596281908990011
Mean error with test set:  0.46448390677025525
X subset =  6 , i =  5
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4554661487236404
Mean error with test set:  0.5061043285238623
X subset =  6 , i =  6
0
1
2
3
4
5
6
7
```

8
9
Mean error with orig set: 0.5207547169811321
Mean error with test set: 0.5055493895671476
X subset = 6 , i = 7
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4596281908990011
Mean error with test set: 0.46448390677025525
X subset = 6 , i = 8
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4609322974472808
Mean error with test set: 0.4514428412874584
X subset = 6 , i = 9
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4656492785793563
Mean error with test set: 0.40427302996670367
X subset = 6 , i = 10
0
1
2
3

4
5
6
7
8
9
Mean error with orig set: 0.4656492785793563
Mean error with test set: 0.40427302996670367
X subset = 7 , i = 0
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4222253052164262
Mean error with test set: 0.4542175360710322
X subset = 7 , i = 1
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.41897891231964485
Mean error with test set: 0.48668146503884574
X subset = 7 , i = 2
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.42938401775804663
Mean error with test set: 0.38263041065482795
X subset = 7 , i = 3

```
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4271920088790233
Mean error with test set:  0.40455049944506105
X subset =  7 , i =   4
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4252774694783574
Mean error with test set:  0.4236958934517203
X subset =  7 , i =   5
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4322419533851276
Mean error with test set:  0.46198668146503885
X subset =  7 , i =   6
0
1
2
3
4
5
6
7
8
```

9
Mean error with orig set: 0.42333518312985574
Mean error with test set: 0.44311875693673697
X subset = 7 , i = 7
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.42602663706992233
Mean error with test set: 0.416204217536071
X subset = 7 , i = 8
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4331853496115427
Mean error with test set: 0.4525527192008879
X subset = 7 , i = 9
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.42852386237513873
Mean error with test set: 0.3912319644839068
X subset = 7 , i = 10
0
1
2
3
4

5
6
7
8
9
Mean error with orig set: 0.43776359600443954
Mean error with test set: 0.40677025527192007
X subset = 8 , i = 0
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4296892341842397
Mean error with test set: 0.46587125416204217
X subset = 8 , i = 1
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4241953385127636
Mean error with test set: 0.4447835738068812
X subset = 8 , i = 2
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.42341842397336293
Mean error with test set: 0.42064372918978915
X subset = 8 , i = 3
0

```
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.42372364039955607
Mean error with test set:  0.4611542730299667
X subset =  8 , i =  4
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.42333518312985574
Mean error with test set:  0.4325749167591565
X subset =  8 , i =  5
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4224472807991121
Mean error with test set:  0.42758046614872364
X subset =  8 , i =  6
0
1
2
3
4
5
6
7
8
9
```

```
Mean error with orig set:  0.44006659267480575
Mean error with test set:  0.4078801331853496
X subset =  8 , i =  7
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4359322974472808
Mean error with test set:  0.39234184239733627
X subset =  8 , i =  8
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4269145394006659
Mean error with test set:  0.3976137624861265
X subset =  8 , i =  9
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4656492785793563
Mean error with test set:  0.40427302996670367
X subset =  8 , i =  10
0
1
2
3
4
5
```

6
7
8
9
Mean error with orig set: 0.42991120976692565
Mean error with test set: 0.40316315205327413
X subset = 9 , i = 0
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.45455049944506104
Mean error with test set: 0.5044395116537181
X subset = 9 , i = 1
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.5126526082130966
Mean error with test set: 0.44561598224195337
X subset = 9 , i = 2
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4786625971143174
Mean error with test set: 0.5238623751387348
X subset = 9 , i = 3
0
1

```
2
3
4
5
6
7
8
9
Mean error with orig set:  0.44922308546059936
Mean error with test set:  0.4830743618201998
X subset =  9 , i =  4
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4503607103218646
Mean error with test set:  0.44977802441731407
X subset =  9 , i =  5
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4719478357380688
Mean error with test set:  0.45615982241953384
X subset =  9 , i =  6
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4907325194228635
```

```
Mean error with test set:   0.4442286348501665
X subset =   9 , i =   7
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:   0.45682574916759155
Mean error with test set:   0.4522752497225305
X subset =   9 , i =   8
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:   0.4588235294117647
Mean error with test set:   0.4486681465038846
X subset =   9 , i =   9
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:   0.4602663706992231
Mean error with test set:   0.40038845726970035
X subset =   9 , i =   10
0
1
2
3
4
5
6
```

7
8
9
Mean error with orig set: 0.46775804661487236
Mean error with test set: 0.4733629300776915
X subset = 10 , i = 0
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.5090455049944506
Mean error with test set: 0.48473917869034405
X subset = 10 , i = 1
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.44736403995560486
Mean error with test set: 0.5380133185349611
X subset = 10 , i = 2
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.49600443951165374
Mean error with test set: 0.5552164261931187
X subset = 10 , i = 3
0
1
2

3
4
5
6
7
8
9
Mean error with orig set: 0.4700055493895671
Mean error with test set: 0.5097114317425083
X subset = 10 , i = 4
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.45849056603773586
Mean error with test set: 0.46614872364039955
X subset = 10 , i = 5
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.47433407325194227
Mean error with test set: 0.46809100998890124
X subset = 10 , i = 6
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.46084905660377357
Mean error with test set: 0.4547724750277469

```
X subset =  10 , i =  7
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4639012208657048
Mean error with test set:  0.46392896781354054
X subset =  10 , i =  8
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.5026359600443951
Mean error with test set:  0.49334073251942284
X subset =  10 , i =  9
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4634850166481687
Mean error with test set:  0.416204217536071
X subset =  10 , i =  10
0
1
2
3
4
5
6
7
```

8
9
Mean error with orig set: 0.46556603773584904
Mean error with test set: 0.40482796892341844
X subset = 11 , i = 0
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4556881243063263
Mean error with test set: 0.5038845726970034
X subset = 11 , i = 1
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4444506104328524
Mean error with test set: 0.5307991120976693
X subset = 11 , i = 2
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.45715871254162044
Mean error with test set: 0.40843507214206437
X subset = 11 , i = 3
0
1
2
3

4
5
6
7
8
9
Mean error with orig set: 0.45638179800221973
Mean error with test set: 0.4125971143174251
X subset = 11 , i = 4
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.4596281908990011
Mean error with test set: 0.46448390677025525
X subset = 11 , i = 5
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.44864039955604884
Mean error with test set: 0.4897336293007769
X subset = 11 , i = 6
0
1
2
3
4
5
6
7
8
9
Mean error with orig set: 0.44938956714761374
Mean error with test set: 0.4902885682574917
X subset = 11 , i = 7

```
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.4556326304106548
Mean error with test set:  0.46198668146503885
X subset =  11 , i =   8
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.45394006659267483
Mean error with test set:  0.4447835738068812
X subset =  11 , i =   9
0
1
2
3
4
5
6
7
8
9
Mean error with orig set:  0.46803551609322974
Mean error with test set:  0.4328523862375139
X subset =  11 , i =   10
0
1
2
3
4
5
6
7
8
```

```
9
Mean error with orig set:  0.46293007769145395
Mean error with test set:  0.43118756936736957
Mean Error for training set, X subset  1  =  [0.47210423]
Mean Error for test set, X subset  1  =  [0.47379175]
Mean Error for training set, X subset  2  =  [0.48256483]
Mean Error for test set, X subset  2  =  [0.46791444]
Mean Error for training set, X subset  3  =  [0.47301483]
Mean Error for test set, X subset  3  =  [0.46637574]
Mean Error for training set, X subset  4  =  [0.45546615]
Mean Error for test set, X subset  4  =  [0.46783877]
Mean Error for training set, X subset  5  =  [0.47441479]
Mean Error for test set, X subset  5  =  [0.47442236]
Mean Error for training set, X subset  6  =  [0.39919282]
Mean Error for test set, X subset  6  =  [0.39925335]
Mean Error for training set, X subset  7  =  [0.47079003]
Mean Error for test set, X subset  7  =  [0.47147109]
Mean Error for training set, X subset  8  =  [0.42764857]
Mean Error for test set, X subset  8  =  [0.42942185]
Mean Error for training set, X subset  9  =  [0.43138937]
Mean Error for test set, X subset  9  =  [0.42344365]
Mean Error for training set, X subset  10  =  [0.46834578]
Mean Error for test set, X subset  10  =  [0.46198668]
Mean Error for training set, X subset  11  =  [0.47378922]
Mean Error for test set, X subset  11  =  [0.47772677]
```

[ ]: