HW2_2copy

October 30, 2018

In [241]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
f=open('SFE_Test_Data.txt','r')
SFE_testf=f.read()
f.close

f=open('SFE_Train_Data.txt','r')
SFE_trainf=f.read()
f.close
```

Out[241]:
```
<function TextIOWrapper.close()>
```

In [54]:
```
def list_concat(word):
    out=''
    for i in word:
        out+=i
    return(out)
```

In [55]:
```
temp=[]
SFE_train=[]
for t in SFE_trainf:
    if(t!='\n' and t!='\t'):
        temp.append(t)
    else:
        SFE_train.append(temp)
        temp=[]
temp=[]
SFE_test=[]
for t in SFE_testf:
    if(t!='\n' and t!='\t'):
        temp.append(t)
    else:
        SFE_test.append(temp)
        temp=[]
```

In [56]:
```
SFE_train1=[]
for i in SFE_train:
```

```
            SFE_train1.append(list_concat(i))
        SFE_test1=[]
        for i in SFE_test:
            SFE_test1.append(list_concat(i))
```

In [57]:
```
cols=SFE_train1[0:8]
train=SFE_train1[8:len(SFE_train1)]

cols=SFE_test1[0:8]
test=SFE_test1[8:len(SFE_test1)]
```

In [58]:
```
train3=[]
for i in train:
    if (i=='High'):
        train3.append(float(1))
    elif (i=='Low'):
        train3.append(float(0))
    else:
        train3.append(float(i))

test3=[]
for i in test:
    if (i=='High'):
        test3.append(float(1))
    elif (i=='Low'):
        test3.append(float(0))
    else:
        test3.append(float(i))
```

In [59]:
```
train1=np.array(train3)
test1=np.array(test3)
```

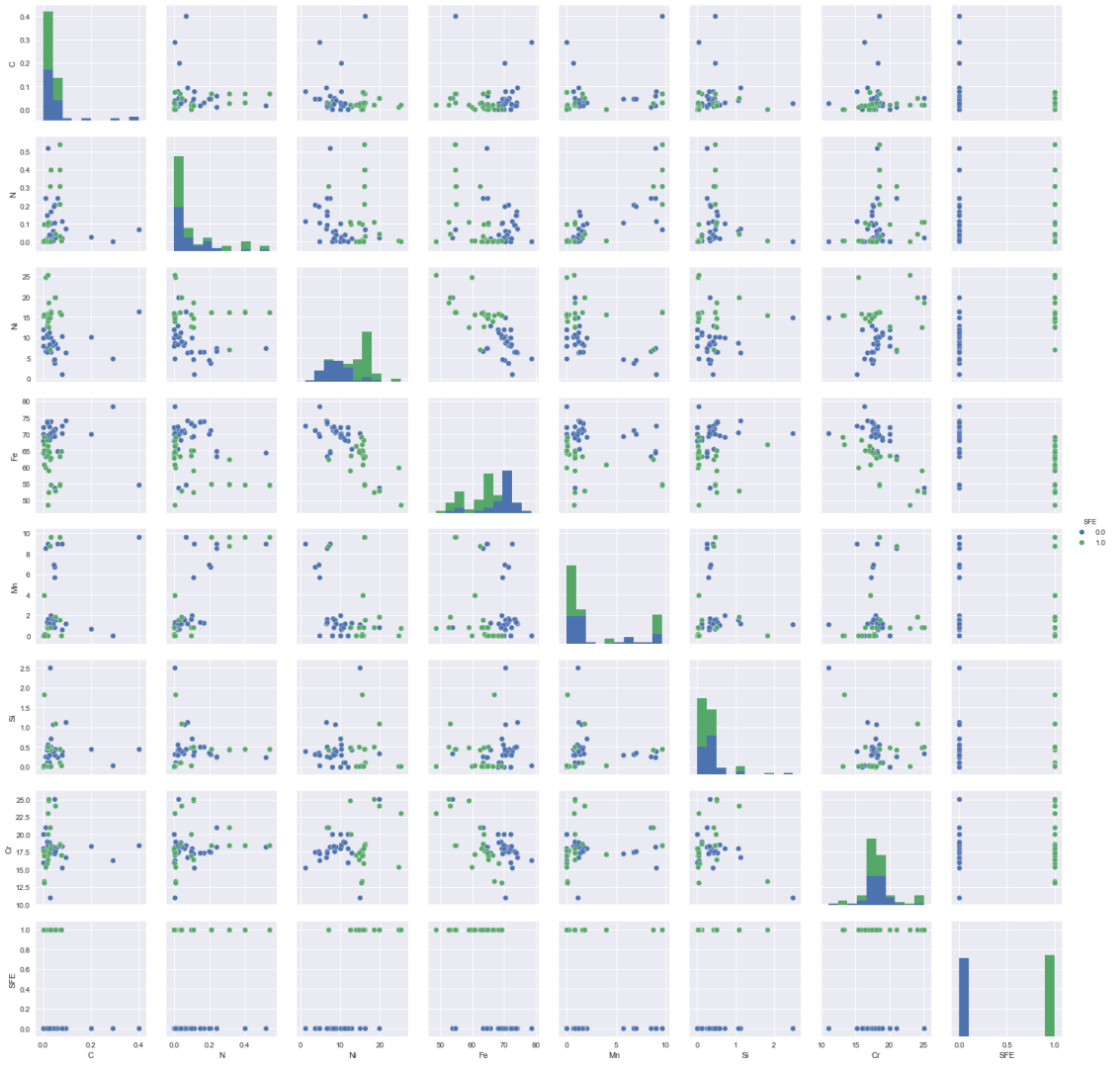
In [60]:
```
train4=np.reshape(train1,(25,8))
test4=np.reshape(test1,(int(len(test1)/8),8))
```

In [61]:
```
len(test1)/8
```

Out[61]:
```
98.0
```

In [62]:
```
traindf=pd.DataFrame(data=train4,columns=cols)
testdf=pd.DataFrame(data=test4,columns=cols)
```

In [244]:
```
testdf
 #scatterplot
 sns.set()
 sns.pairplot(testdf, size = 2.5,hue='SFE')
 plt.show();
```




```
In [312]: import numpy as np
          import matplotlib.pyplot as plt
          from sklearn.discriminant_analysis import LinearDiscriminantAnalysis
          from sklearn.neighbors import KNeighborsClassifier
          from itertools import combinations

          #Exhaustive search
          #Obtain combinations of size r
          train_cols=traindf.columns[0:7]
          test_cols=testdf.columns[0:7]

          all_combs=[]
          all_combs_feat=[]
          for ncomb in range(1,6):
```

```
                #combinations of features
                col_comb = list(combinations(train_cols, ncomb))
                count=0
                score_combs=np.zeros([len(col_comb),4])
                sel_feat=[]
                print('N features', ncomb)
                #import pdb; pdb.set_trace()
                for col_i in col_comb :

                    X_train=traindf.loc[:,col_i]
                    Y_train=traindf.loc[:,'SFE']

                    X_test=testdf.loc[:,col_i]
                    Y_test=testdf.loc[:,'SFE']

                    #model1
                    model1 = LinearDiscriminantAnalysis()
                    model1.fit(X_train, Y_train)
                    LinearDiscriminantAnalysis(n_components=None, priors=None, shrinkage=None,
                    solver='svd', store_covariance=False, tol=0.0001)

                    #model2
                    model2 = KNeighborsClassifier(n_neighbors=3)
                    model2.fit(X_train, Y_train)
                    KNeighborsClassifier(...)

                    #acccuracy for this iteration
                    score_combs[count,0]=model1.score(X_train,Y_train)
                    score_combs[count,1]=model2.score(X_train,Y_train)
                    score_combs[count,2]=model1.score(X_test,Y_test)
                    score_combs[count,3]=model2.score(X_test,Y_test)
                    #print('Count score',score_combs)
                    count+=1
                    sel_feat.append(col_i)
                all_combs_feat.append(sel_feat)
                all_combs.append(score_combs)
```

```
N features 1
N features 2
N features 3
N features 4
N features 5
```

```
In [83]: x=all_combs[0][:,0]
```

```
[0.72 0.52 0.84 0.88 0.6  0.68 0.6 ]
```

```
In [95]: all_combs_feat[0]

Out[95]: ('C',)

In [97]: from operator import itemgetter
         maxscore=[]
         maxscore_feat=[]
         maxscore.append(max(enumerate(x), key=itemgetter(1))[1])
         maxscore_feat.append(all_combs_feat[0][max(enumerate(x), key=itemgetter(1))[0]])

In [105]: type(maxscore_feat)

Out[105]: list

In [118]: score_max=[]
          feat_set=[]
          #number of features to be considered
          for nfeat in range (0,5):
              maxscore=[]
              best_feat=[]
              #different models and err types
              for i in range (0,4):
                  x=all_combs[nfeat][:,i]
                  maxscore.append(max(enumerate(x), key=itemgetter(1))[1])
                  best_feat.append(all_combs_feat[nfeat][max(enumerate(x), key=itemgetter(1))[
              score_max.append(maxscore)
              feat_set.append(best_feat)

In [157]: varlda_app=[]
          varlda_test=[]
          varknn_app=[]
          varknn_test=[]
          errlda_app=[]
          errlda_test=[]
          errknn_app=[]
          errknn_test=[]
          for i in range(0,5):
              varlda_app.append(feat_set[i][0])
              varlda_test.append(feat_set[i][1])
              varknn_app.append(feat_set[i][2])`
              varknn_test.append(feat_set[i][3])
              errlda_app.append(1-score_max[i][0])
              errlda_test.append(1-score_max[i][1])
              errknn_app.append(1-score_max[i][2])
              errknn_test.append(1-score_max[i][3])

In [201]: dat=[]
          for i in range(0,8):
              dat.append([])
```

```
dat[0].append('Features')
dat[1].append('LDA_apparent Error')
dat[2].append('Features')
dat[3].append('KNN_apparent Error')
dat[4].append('Features')
dat[5].append('LDA_test Error')
dat[6].append('Features')
dat[7].append('KNN_test Error')

for i in range(0,5):
    dat[0].append(feat_set[i][0])
    dat[2].append(feat_set[i][1])
    dat[4].append(feat_set[i][2])
    dat[6].append(feat_set[i][3])
    dat[1].append(1-score_max[i][0])
    dat[3].append(1-score_max[i][1])
    dat[5].append(1-score_max[i][2])
    dat[7].append(1-score_max[i][3])
```

In [204]:
```
labs=['Categories','1 Feature','2 Features','3 Features','4 Features','5 Features']
df1=pd.DataFrame(data=dat,columns=labs)
df1
```

Out[204]:

	Categories	1 Feature	2 Features	3 Features	4 Features	5 Features
0	Features	(Fe,)	(C, Fe)	(C, Ni, Fe)	(C, N, Fe, Mn)	(N, Ni, Fe, Si, Cr)
1	LDA_apparent Error	0.12	0.04	0.04	0.04	0
2	Features	(Mn,)	(C, Mn)	(C, N, Mn)	(C, N, Ni, Fe)	(C, N, Ni, Fe, Mn)
3	KNN_apparent Error	0.04	0.04	0.04	0.04	0.04
4	Features	(Ni,)	(N, Ni)	(C, Ni, Fe)	(C, N, Ni, Si)	(C, Fe, Mn, Si, Cr)
5	LDA_test Error	0.122449	0.0714286	0.0612245	0.0510204	0.0408163
6	Features	(Ni,)	(Ni, Fe)	(C, Ni, Fe)	(C, N, Ni, Fe)	(C, N, Ni, Fe, Mn)
7	KNN_test Error	0.0918367	0.0612245	0.0612245	0.0612245	0.0612245

In [311]:
```
#Sequential forward search
train_cols=traindf.columns[0:7]
test_cols=testdf.columns[0:7]
```

```
#initialize variables for storing features and scores
all_combs=[]
all_combs_feat=[]
chosen_feat=[]
score_max=[]
for i in range(0,4):
    chosen_feat.append([])
    score_max.append([])
feat_set=[]


#keep adding one feature at a time
for nfeat in range(1,6):
    #combinations of features
    #keep track of remaining columns separately for each path
    rem_cols=[]
    for j in range(0,4):
        rem_cols.append([])
    for i in range(0,4):
        for t in train_cols:
            if (t not in chosen_feat[i]):
                rem_cols[i].append(t)

    score_combs=np.zeros([len(rem_cols[0]),4])
    sel_feat=[]
    for i in range(0,4):
        sel_feat.append([])
    #for each of the four paths
    for path in range (0,4) :
        count=0
        for col_i in rem_cols[path]:
            X_train=traindf.loc[:,chosen_feat[path]+list([col_i])]
            Y_train=traindf.loc[:,'SFE']

            X_test=testdf.loc[:,chosen_feat[path]+list([col_i])]
            Y_test=testdf.loc[:,'SFE']
            #import pdb; pdb.set_trace()
            #model1
            model1 = LinearDiscriminantAnalysis()
            model1.fit(X_train, Y_train)
            LinearDiscriminantAnalysis(n_components=None, priors=None, shrinkage=None
            solver='svd', store_covariance=False, tol=0.0001)

            #model2
            model2 = KNeighborsClassifier(n_neighbors=3)
            model2.fit(X_train, Y_train)
            KNeighborsClassifier(...)
```

```
                    #acccuracy for this iteration
                    if (path==0):
                        score_combs[count,0]=model1.score(X_train,Y_train)
                    elif(path==1):
                        score_combs[count,1]=model2.score(X_train,Y_train)
                    elif(path==2):
                        score_combs[count,2]=model1.score(X_test,Y_test)
                    else:
                        score_combs[count,3]=model2.score(X_test,Y_test)
                    count+=1
                    sel_feat[path].append(col_i)
                #print('Chosen Features ',path,chosen_feat,'\n',score_combs)
            all_combs.append(score_combs)
            for i in range (0,4):
                x=all_combs[nfeat-1][:,i]
                maxscore=(max(enumerate(x), key=itemgetter(1))[1])
                best_feat=(sel_feat[i][max(enumerate(x), key=itemgetter(1))[0]])
                score_max[i].append(maxscore)
                chosen_feat[i].append(best_feat)
            #all_combs_feat[i].append(chosen_feat)
            #import pdb; pdb.set_trace()
```

```
In [300]: score_max
```

```
Out[300]: [[0.88, 0.96, 0.96, 0.96, 0.96],
           [0.96, 0.96, 0.96, 0.96, 0.92],
           [0.8775510204081632,
            0.9285714285714286,
            0.9285714285714286,
            0.9489795918367347,
            0.9081632653061225],
           [0.9081632653061225,
            0.9387755102040817,
            0.9387755102040817,
            0.9387755102040817,
            0.9387755102040817]]
```

```
In [290]: all_combs_feat
```

```
Out[290]: [[['Fe', 'C', 'Ni', 'Mn', 'N'],
            ['Mn', 'C', 'N', 'Si', 'Ni'],
            ['Ni', 'N', 'C', 'Si', 'Mn'],
            ['Ni', 'Fe', 'C', 'N', 'Mn']],
           [['Fe', 'C', 'Ni', 'Mn', 'N'],
            ['Mn', 'C', 'N', 'Si', 'Ni'],
            ['Ni', 'N', 'C', 'Si', 'Mn'],
            ['Ni', 'Fe', 'C', 'N', 'Mn']],
           [['Fe', 'C', 'Ni', 'Mn', 'N'],
            ['Mn', 'C', 'N', 'Si', 'Ni'],
```

```
  ['Ni', 'N', 'C', 'Si', 'Mn'],
  ['Ni', 'Fe', 'C', 'N', 'Mn']],
 [['Fe', 'C', 'Ni', 'Mn', 'N'],
  ['Mn', 'C', 'N', 'Si', 'Ni'],
  ['Ni', 'N', 'C', 'Si', 'Mn'],
  ['Ni', 'Fe', 'C', 'N', 'Mn']],
 [['Fe', 'C', 'Ni', 'Mn', 'N'],
  ['Mn', 'C', 'N', 'Si', 'Ni'],
  ['Ni', 'N', 'C', 'Si', 'Mn'],
  ['Ni', 'Fe', 'C', 'N', 'Mn']]]
```

In [220]:
```
a=['p']
b=['tt']
c=list(b)
a+c
```

Out[220]:
```
['p', 'tt']
```

In [308]:
```
dat=[]
for i in range(0,8):
    dat.append([])

dat[0].append('Features')
dat[1].append('LDA_apparent Error')
dat[2].append('Features')
dat[3].append('KNN_apparent Error')
dat[4].append('Features')
dat[5].append('LDA_test Error')
dat[6].append('Features')
dat[7].append('KNN_test Error')

for i in range(0,5):
    dat[0].append(chosen_feat[0][i])
    dat[2].append(chosen_feat[1][i])
    dat[4].append(chosen_feat[2][i])
    dat[6].append(chosen_feat[3][i])
    dat[1].append(1-score_max[0][i])
    dat[3].append(1-score_max[1][i])
    dat[5].append(1-score_max[2][i])
    dat[7].append(1-score_max[3][i])
```

In [310]:
```
labs=['Categories','1st Feature','2nd Feature','3rd Feature','4th Feature','5th Featu
df1=pd.DataFrame(data=dat,columns=labs)
df1
```

Out[310]:

	Categories	1st Feature	2nd Feature	3rd Feature	4th Feature	\
0	Features	Fe	C	Ni	Mn	
1	LDA_apparent Error	0.12	0.04	0.04	0.04	
2	Features	Mn	C	N	Si	

```
3  KNN_apparent Error        0.04        0.04        0.04        0.04
4            Features          Ni           N           C          Si
5      LDA_test Error    0.122449   0.0714286   0.0714286   0.0510204
6            Features          Ni          Fe           C           N
7      KNN_test Error   0.0918367   0.0612245   0.0612245   0.0612245

  5th Feature
0           N
1        0.04
2          Ni
3        0.08
4          Mn
5   0.0918367
6          Mn
7   0.0612245
```

In [307]:
```
score_max[0]
```

Out[307]:
```
[0.88, 0.96, 0.96, 0.96, 0.96]
```