

Materials Informatics – Fall 2017
Computer Final Project – Solutions

Due on: Dec 15 2017 11:59pm

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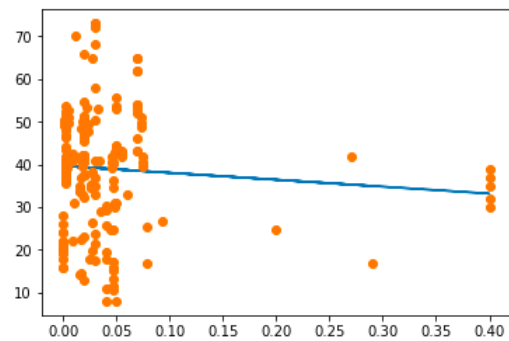
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1 Assignment

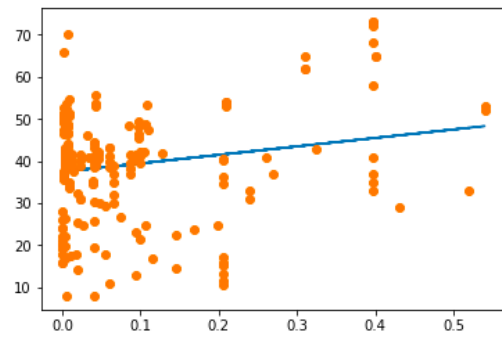
a)

	R2	MSE	Coef
C	0.006946233	167.4806988	-16.20037641
N	0.034959498	162.7562002	20.0884865
Ni	0.497966097	84.66912027	2.33533817
Fe	0.405297187	100.2979356	-1.44043074
Mn	0.008429205	167.2305924	0.34560156
Si	0.009027444	167.1296981	-3.52081655
Cr	0.007253678	167.4288475	0.52131769

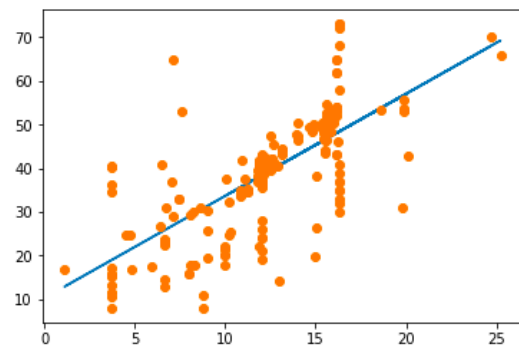
According to r2 value Ni is the best predictor of SRE



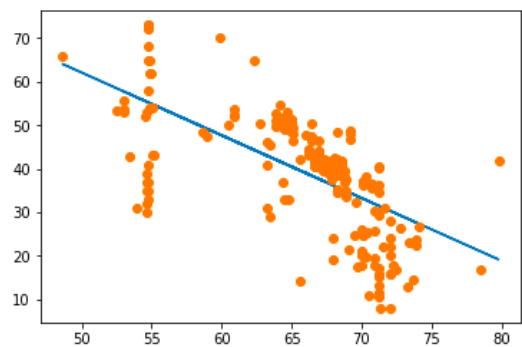
C



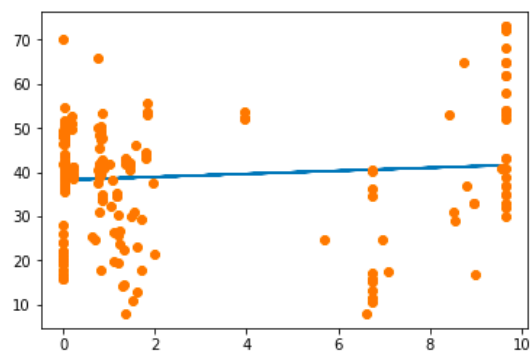
N



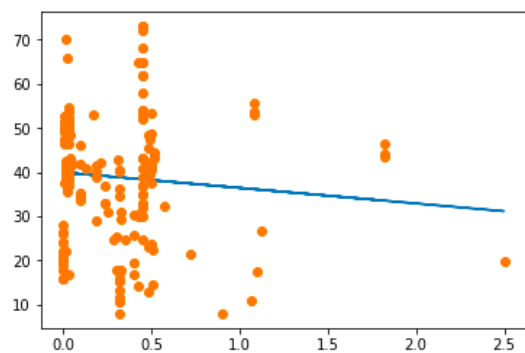
Ni



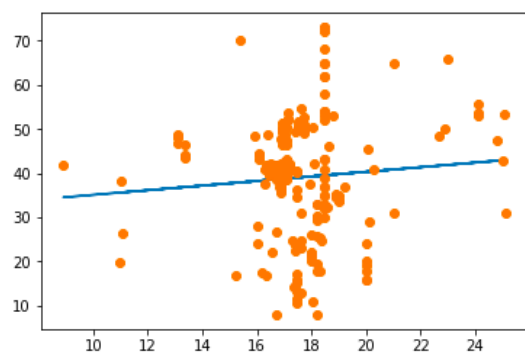
Fe



Mn



Si



Cr

The better r^2 value will give us a better linear model, so the plot of points will be closer to the line that we drew in the graph, so Ni is the best graph.

2)

exhaustive	R2	Mse	Coef	ADR2
Ni	0.4979	84.669	[2.33533817]	0.4980
N,Ni	0.5535	75.300	[25.38118739, 2.38869609]	0.5513
Fe,Mn,Cr	0.5944	68.390	[-2.3525984 , -1.41578646, -2.36709473]	0.5905
C,Fe,Mn,Cr	0.6321	62.032	[-41.60904346, -2.40349844, -1.11265247, -2.50073457]	0.6268
C,Fe,Mn,Si,C r	0.6621	56.97	[-39.99242382, -2.44414191, -0.95862936, -6.71416018, -2.62653818]	0.6555

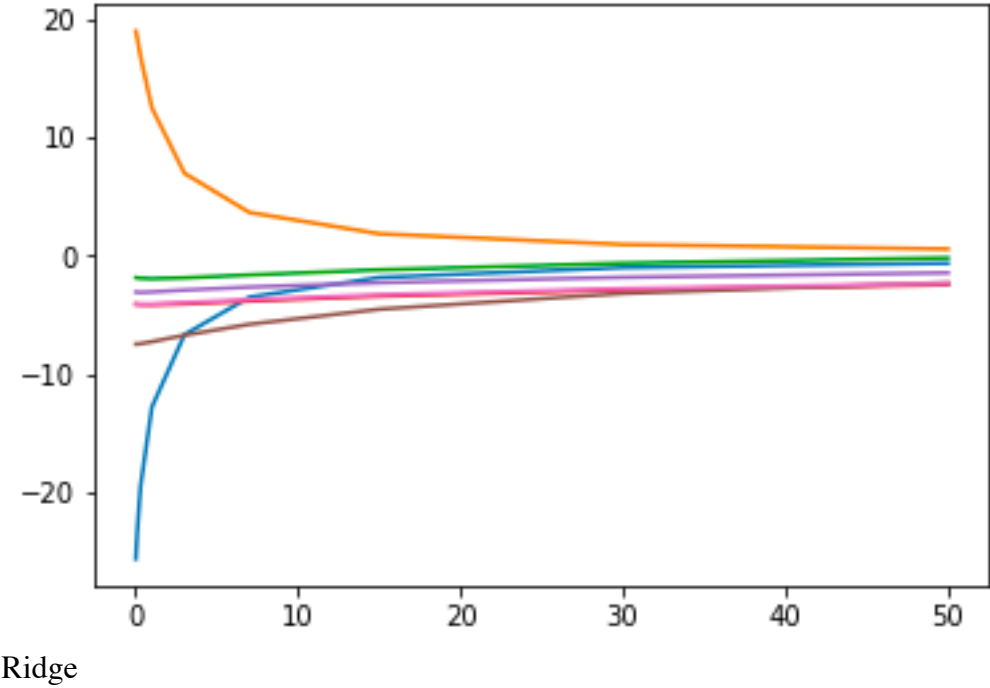
sequential	R2	Mse	Coef	ADR2
Ni	0.4979	84.669	[2.33533817]	0.4979
Ni,N	0.5535	75.300	[2.38869609, 25.38118739]	0.5513
Ni,N,Si	0.5782	71.133	[2.40089754, 29.27877211, -5.97779099]	0.5741
Ni,N,Si,C	0.5920	68.799	[2.42139354, 29.95825006, -5.32505189, -23.21994118]	0.5861
Ni,N,Si,C,Fe	0.6000	67.448	[1.92824932, 19.16906455, -5.52210355, -29.81984612, -0.45707106]	0.5920

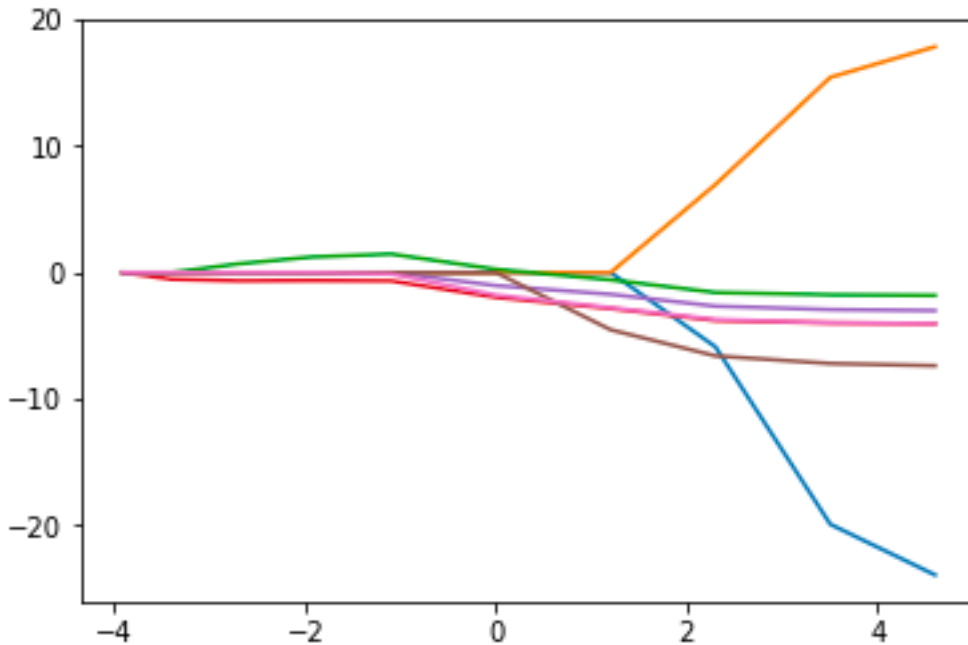
By comparing adjusted r2, exhaustive search will provide the best result. The result from this lab has a huge difference compare to lab 2. Because in lab 2 we have used exhaustive and sequential forward search for both 3NN and LDA model. So due to different method, the result may vary.

3)

	50	30	15	7	3
Lasso	-23.8941 17.8405 -1.80917 -4.03552 -3.00736 -7.36171 -4.03878	-5.87233 6.95656 -1.57728 -3.79092 -2.66081 -6.58614 -3.70373	0 0 -0.577367 -2.84754 -1.71977 -4.52486 -2.77422	0 0 0.254709 -1.9607 -1.03157 0 -1.77636	0 0 1.46059 -0.660669 0 0 -0.115087
Ridge	-25.5921 18.988 -1.8382 -4.06524 -3.04905 -7.44783 -4.07715	-25.0109 18.8583 -1.8438 4.06952 -3.0543 -7.44719 -4.07877	-23.212 18.3601 -1.86083 -4.08248 -3.06777 -7.44217 -4.08299	-19.4332 16.8218 -1.89402 -4.10731 -3.08105 -7.4124 -4.08683	-12.7535 12.4901 -1.92885 -4.12878 -3.04368 -7.24388 -4.0632
	1	0.3	0.1	0.03	0.01
Lasso	0 0 0	0 0 1.22094	0 0 0.679961	0 0 0	0 0 0

	1.46059	0.633447	-0.654028	-0.529804	0
	-0.660669	0	0	-0	0
	0	0	0	-0	0
	0.115087	0	0	-0	0
Ridge	-6.65414	-3.47978	-1.82206	-0.983493	-0.616655
	6.97925	3.66951	1.86942	0.965932	0.583707
	-1.85359	-1.60731	-1.17524	-0.618931	-0.164284
	-4.04712	-3.80853	-3.39639	-2.86653	-2.43092
	-2.88682	-2.63424	-2.26303	-1.80494	-1.4309
	-6.70076	-5.77591	-4.50131	-3.16572	-2.25779
	-3.93595	-3.67946	-3.26961	-2.75213	-2.32398





Lasso

2 Assignment

a). convolution layer

	Layer1	Layer2	Layer3	Layer4	Layer5
Spheroidite,Network	0.495	0.41	0.445	0.49	0.003
Spheroidite,Pearlite	0.5	0.49	0.49	0.5	0.035
Spheroidite,Spheroidite+widmanstatten	0.375	0.375	0.375	0.445	0.375
Network,Pearlite	0.5	0.41	0.445	0.5	0.035
Network,Spheroidite+Widmanstatten	0.375	0.375	0.375	0.375	0.012
Pearlite,Spheroidite+widmanstatten	0.375	0.375	0.445	0.375	0.112

By observing the result from part a, we can find that the layer 5 stall has the best result, but for spheroidite, spheroidite+widmanstatten, we can see the error is not being smaller at layer5, that is because spheroidite+widmanstatten has a part of feature of spheroidite.

b). One Vs One error

spheroidite	0.0401
pearlite	0
network	0.0982
spheroidite+Widmanstatten	0.4285

Pairwise Classifier error

spheroidite	0.0134
pearlite	0

network	0.0863
spheroidite+Widmanstätten	0.2063

By comparing two results, we can state that the pairwise classifier provide a better error than one vs one classifier.

c). Label for pearlite + spheroidite

micrograph4.tif	spheroidite	micrograph779.tif	spheroidite
micrograph12.tif	spheroidite	micrograph808.tif	pearlite
micrograph15.tif	spheroidite	micrograph825.tif	spheroidite
micrograph62.tif	pearlite	micrograph866.tif	pearlite
micrograph71.tif	spheroidite	micrograph871.tif	spheroidite
micrograph109.tif	spheroidite	micrograph908.tif	pearlite
micrograph111.tif	spheroidite	micrograph910.tif	pearlite
micrograph119.tif	spheroidite	micrograph916.tif	spheroidite
micrograph131.tif	spheroidite	micrograph926.tif	spheroidite
micrograph137.tif	pearlite	micrograph994.tif	pearlite
micrograph166.tif	spheroidite	micrograph997.tif	spheroidite
micrograph186.tif	spheroidite	micrograph1033.tif	spheroidite
micrograph193.tif	spheroidite	micrograph1068.tif	spheroidite
micrograph201.tif	spheroidite	micrograph1168.tif	spheroidite
micrograph211.tif	spheroidite	micrograph1206.tif	spheroidite
micrograph224.tif	spheroidite	micrograph1226.tif	spheroidite
micrograph245.tif	spheroidite	micrograph1227.tif	spheroidite
micrograph288.tif	spheroidite	micrograph1241.tif	spheroidite
micrograph342.tif	spheroidite	micrograph1243.tif	spheroidite
micrograph380.tif	spheroidite	micrograph1247.tif	spheroidite
micrograph404.tif	spheroidite	micrograph1268.tif	spheroidite
micrograph431.tif	spheroidite	micrograph1271.tif	spheroidite
micrograph453.tif	spheroidite	micrograph1303.tif	spheroidite
micrograph466.tif	pearlite	micrograph1357.tif	spheroidite
micrograph481.tif	spheroidite	micrograph1366.tif	spheroidite
micrograph483.tif	spheroidite	micrograph1390.tif	pearlite
micrograph499.tif	spheroidite	micrograph1398.tif	pearlite
micrograph515.tif	spheroidite	micrograph1414.tif	spheroidite
micrograph522.tif	spheroidite	micrograph1432.tif	pearlite
micrograph532.tif	spheroidite	micrograph1433.tif	spheroidite
micrograph541.tif	spheroidite	micrograph1441.tif	spheroidite
micrograph544.tif	spheroidite	micrograph1450.tif	spheroidite
micrograph567.tif	spheroidite	micrograph1455.tif	spheroidite

micrograph572.tif	spheroidite	micrograph1458.tif	spheroidite
micrograph576.tif	spheroidite	micrograph1489.tif	pearlite
micrograph602.tif	spheroidite	micrograph1502.tif	pearlite
micrograph609.tif	spheroidite+widmanstatten	micrograph1503.tif	spheroidite
micrograph637.tif	spheroidite	micrograph1513.tif	spheroidite
micrograph644.tif	pearlite	micrograph1514.tif	pearlite
micrograph648.tif	spheroidite	micrograph1525.tif	spheroidite
micrograph656.tif	pearlite	micrograph1526.tif	pearlite
micrograph660.tif	spheroidite	micrograph1527.tif	spheroidite
micrograph672.tif	pearlite	micrograph1532.tif	spheroidite
micrograph676.tif	pearlite	micrograph1570.tif	pearlite
micrograph677.tif	spheroidite	micrograph1574.tif	spheroidite
micrograph704.tif	spheroidite	micrograph1582.tif	spheroidite
micrograph716.tif	spheroidite	micrograph1595.tif	pearlite
micrograph727.tif	spheroidite	micrograph1635.tif	spheroidite
micrograph742.tif	spheroidite	micrograph1643.tif	spheroidite
micrograph749.tif	spheroidite+widmanstatten	micrograph1644.tif	spheroidite
micrograph758.tif	spheroidite	micrograph1656.tif	pearlite
micrograph765.tif	pearlite	micrograph1657.tif	spheroidite
micrograph771.tif	spheroidite	micrograph1662.tif	spheroidite
		micrograph1668.tif	network

Label for pearlite + widmanstatten

pearlite	micrograph346.tif
pearlite	micrograph490.tif
pearlite	micrograph496.tif
spheroidite	micrograph523.tif
spheroidite+widmanstatten	micrograph553.tif
pearlite	micrograph753.tif
spheroidite	micrograph836.tif
pearlite	micrograph857.tif
spheroidite	micrograph875.tif
spheroidite	micrograph882.tif
pearlite	micrograph911.tif
pearlite	micrograph932.tif
pearlite	micrograph1046.tif
spheroidite	micrograph1078.tif
spheroidite	micrograph1097.tif

pearlite	micrograph1104.tif
pearlite	micrograph1123.tif
pearlite	micrograph1204.tif
spheroidite	micrograph1214.tif
spheroidite+widmanstatten	micrograph1215.tif
pearlite	micrograph1255.tif
pearlite	micrograph1267.tif
pearlite	micrograph1287.tif
spheroidite+widmanstatten	micrograph1370.tif
pearlite	micrograph1395.tif
spheroidite	micrograph1417.tif
pearlite	micrograph1684.tif

By obverting those two results, we can find that our one vs one classifier by using layer 5 is good enough to be a classifier

d).

spheroidite	micrograph4.tif	spheroidite
spheroidite	micrograph12.tif	spheroidite
spheroidite	micrograph15.tif	spheroidite
pearlite	micrograph62.tif	pearlite
spheroidite	micrograph71.tif	spheroidite
spheroidite	micrograph109.tif	spheroidite
spheroidite	micrograph111.tif	spheroidite
spheroidite	micrograph119.tif	spheroidite
spheroidite	micrograph131.tif	spheroidite
pearlite	micrograph137.tif	pearlite
spheroidite	micrograph166.tif	spheroidite
spheroidite	micrograph186.tif	spheroidite
spheroidite	micrograph193.tif	spheroidite
spheroidite	micrograph201.tif	spheroidite
spheroidite	micrograph211.tif	spheroidite
spheroidite	micrograph224.tif	spheroidite
spheroidite	micrograph245.tif	spheroidite
spheroidite	micrograph288.tif	spheroidite
spheroidite	micrograph342.tif	spheroidite
spheroidite	micrograph380.tif	spheroidite
spheroidite	micrograph404.tif	spheroidite

spheroidite	micrograph431.tif	spheroidite
spheroidite	micrograph453.tif	spheroidite
pearlite	micrograph466.tif	pearlite
spheroidite	micrograph481.tif	spheroidite
spheroidite	micrograph483.tif	spheroidite
spheroidite	micrograph499.tif	spheroidite
spheroidite	micrograph515.tif	spheroidite
spheroidite	micrograph522.tif	spheroidite
spheroidite	micrograph532.tif	spheroidite
spheroidite	micrograph541.tif	spheroidite
spheroidite	micrograph544.tif	spheroidite
spheroidite	micrograph567.tif	spheroidite
spheroidite	micrograph572.tif	spheroidite
spheroidite	micrograph576.tif	spheroidite
spheroidite	micrograph602.tif	spheroidite
spheroidite	micrograph609.tif	spheroidite+widmanstatten
spheroidite	micrograph637.tif	spheroidite
pearlite	micrograph644.tif	pearlite
spheroidite	micrograph648.tif	spheroidite
pearlite	micrograph656.tif	pearlite
spheroidite	micrograph660.tif	spheroidite
pearlite	micrograph672.tif	pearlite
pearlite	micrograph676.tif	pearlite
spheroidite	micrograph677.tif	spheroidite
spheroidite	micrograph704.tif	spheroidite
spheroidite	micrograph716.tif	spheroidite
spheroidite	micrograph727.tif	spheroidite
spheroidite	micrograph742.tif	spheroidite
spheroidite	micrograph749.tif	spheroidite+widmanstatten
spheroidite	micrograph758.tif	spheroidite
pearlite	micrograph765.tif	pearlite
spheroidite	micrograph771.tif	spheroidite
spheroidite	micrograph779.tif	spheroidite
pearlite	micrograph808.tif	pearlite
spheroidite	micrograph825.tif	spheroidite
pearlite	micrograph866.tif	pearlite
spheroidite	micrograph871.tif	spheroidite

pearlite	micrograph908.tif	pearlite
pearlite	micrograph910.tif	pearlite
spheroidite	micrograph916.tif	spheroidite
spheroidite	micrograph926.tif	spheroidite
pearlite	micrograph994.tif	pearlite
spheroidite	micrograph997.tif	spheroidite
spheroidite	micrograph1033.tif	spheroidite
spheroidite	micrograph1068.tif	spheroidite
spheroidite	micrograph1168.tif	spheroidite
spheroidite	micrograph1206.tif	spheroidite
spheroidite	micrograph1226.tif	spheroidite
spheroidite	micrograph1227.tif	spheroidite
spheroidite	micrograph1241.tif	spheroidite
spheroidite	micrograph1243.tif	spheroidite
spheroidite	micrograph1247.tif	spheroidite
spheroidite	micrograph1268.tif	spheroidite
spheroidite	micrograph1271.tif	spheroidite
spheroidite	micrograph1303.tif	spheroidite
spheroidite	micrograph1357.tif	spheroidite
spheroidite	micrograph1366.tif	spheroidite
pearlite	micrograph1390.tif	pearlite
pearlite	micrograph1398.tif	pearlite
spheroidite	micrograph1414.tif	spheroidite
pearlite	micrograph1432.tif	pearlite
spheroidite	micrograph1433.tif	spheroidite
spheroidite	micrograph1441.tif	spheroidite
spheroidite	micrograph1450.tif	spheroidite
spheroidite	micrograph1455.tif	spheroidite
spheroidite	micrograph1458.tif	spheroidite
pearlite	micrograph1489.tif	pearlite
pearlite	micrograph1502.tif	pearlite
spheroidite	micrograph1503.tif	spheroidite
spheroidite	micrograph1513.tif	spheroidite
pearlite	micrograph1514.tif	pearlite
spheroidite	micrograph1525.tif	spheroidite
pearlite	micrograph1526.tif	pearlite
spheroidite	micrograph1527.tif	spheroidite

spheroidite	micrograph1532.tif	spheroidite
pearlite	micrograph1570.tif	pearlite
spheroidite	micrograph1574.tif	spheroidite
spheroidite	micrograph1582.tif	spheroidite
pearlite	micrograph1595.tif	pearlite
spheroidite	micrograph1635.tif	spheroidite
spheroidite	micrograph1643.tif	spheroidite
spheroidite	micrograph1644.tif	spheroidite
pearlite	micrograph1656.tif	pearlite
spheroidite	micrograph1657.tif	spheroidite
spheroidite	micrograph1662.tif	spheroidite
spheroidite	micrograph1668.tif	network

The left label is the result from part d and right label is the result from part c, there are totally three difference between part c and d which are micrograph1668, 749 and 609, because one vs one can classify data up to 4 label but pairwise can only do it for 2 label, but it is also mean those two classifiers are good enough.

e). martensite microstructure

spheroidite	micrograph20.tif
network	micrograph41.tif
pearlite	micrograph44.tif
spheroidite	micrograph99.tif
spheroidite	micrograph114.tif
network	micrograph168.tif
spheroidite	micrograph345.tif
pearlite	micrograph366.tif
spheroidite	micrograph381.tif
spheroidite	micrograph459.tif
pearlite	micrograph492.tif
pearlite	micrograph502.tif
pearlite	micrograph785.tif
pearlite	micrograph951.tif
spheroidite	micrograph954.tif
pearlite	micrograph963.tif
spheroidite	micrograph984.tif
pearlite	micrograph1009.tif
spheroidite	micrograph1012.tif
pearlite	micrograph1030.tif
pearlite	micrograph1048.tif

spheroidite	micrograph1055.tif
spheroidite	micrograph1079.tif
pearlite	micrograph1174.tif
spheroidite	micrograph1177.tif
pearlite	micrograph1281.tif
pearlite	micrograph1316.tif
pearlite	micrograph1396.tif
spheroidite	micrograph1424.tif
spheroidite	micrograph1449.tif
pearlite	micrograph1531.tif
network	micrograph1552.tif
spheroidite	micrograph1599.tif
spheroidite	micrograph1697.tif
pearlite	micrograph1700.tif
spheroidite	micrograph1723.tif

Code:

```
#!/usr/bin/env python3
# -*- coding: utf-8 -*-
"""
```

Created on Fri Dec 8 09:46:21 2017

```
@author: jianfengsong
"""
```

```
import xlrd as xl
import numpy as np
import matplotlib.pyplot as plt
import plotly.plotly as py
import plotly.figure_factory as ff
import pandas as pd
import plotly
from sklearn import linear_model
import operator
from itertools import combinations
from sklearn.linear_model import LinearRegression as lnr
from sklearn.metrics import mean_squared_error, r2_score
from sklearn.linear_model import Ridge
class fun():
    def excel_data(n):
        train_rows_value=list()
        train_cols_value=list()
```

```

excel=xl.open_workbook(n)
data_table=excel.sheet_by_index(0)
rows=data_table.nrows
cols=data_table.ncols
for a in range(rows):
    train_rows_value.append(data_table.row_values(a))
train_row=np.asarray(train_rows_value)
data_set=[[[] for x in range(len(train_row)-1)]
for a in range (1,len(train_row),1):
    for b in range(0,len(train_row[a])):
        data_set[a-1].append(float(train_row[a][b]))
return np.asarray(data_set)
#####
##
def get_data():
    data_set=fun.excel_data('SFE_Dataset.xlsx')
    data=data_set.T
    data_1,data_2=list(),list()
    for a in range(len(data)):
        num_0=0
        for b in range(len(data[a])):
            if data[a][b]==0:
                num_0+=1
            else:
                num_0=num_0
        pre_0=num_0/len(data[a])
        if pre_0<=0.4:
            data_1.append(data[a])
    data_1=np.asarray(data_1).T
    for a in range(len(data_1)):
        num_0=0
        for b in range(len(data_1[a])):
            if data_1[a][b]==0:
                num_0+=1
        if num_0==0:
            data_2.append(data_1[a])
    data_good=np.asarray(data_2)
    return data_good
#####
##
def data_clas():
    data_set=fun.get_data()
    data_no_sfe=list()
    data_label=list()
    for a in range(len(data_set)):
        b=len(data_set[a])-1

```

```

        if data_set[a][b]<35:
            data_label.append(data_set[a][b])
        elif data_set[a][b]>45:
            data_label.append(data_set[a][b])
        else:
            data_label.append(data_set[a][b])
    data_set1=data_set.T
    for a in range(0,len(data_set1)-1):
        data_no_sfe.append(data_set1[a])
    data_nosfe=np.asarray(data_no_sfe)
    return data_nosfe,data_label
#####
###
def ehaustive(num):
    selected_feature_set=list()
    selected_feature1=combinations(range(7),num)
    selected_feature=np.asarray(list(selected_feature1))
    return selected_feature
#####
###
def linear(data,label):
    data_coef=list()
    data_mse=list()
    data_r2=list()
    data_list=list()
    data_pred_list=list()
    for a in (range(len(data))):
        data_var=data[a]
        data_var.shape=(211,1)
        data_lnr=lnr()
        data_lnr.fit(data_var,label)
        data_pred=data_lnr.predict(data_var)
        r2_score=data_lnr.score(data_var,label)
        data_list.append(data_var)
        data_pred_list.append(data_pred)
        data_r2.append(r2_score)
        data_coef.append(data_lnr.coef_)
        data_mse.append(mean_squared_error(label,data_pred))
    return data_r2,data_coef,data_mse,data_pred_list
#####
##
def linear_ex(data,label,num_list):
    data_coef=list()
    data_mse=list()
    data_r2=list()
    data_list=list()

```

```

data_pred_list=list()
minr2=0
if len(num_list)==7:
    for a in num_list:
        data_var=data[a,:]
        data_var.shape=(211,1)
        data_lnr=lnr()
        data_lnr.fit(data_var,label)
        data_pred=data_lnr.predict(data_var)
        r2_score=data_lnr.score(data_var,label)
        if minr2<r2_score:
            minr2=r2_score
            minfea=a
            coef=data_lnr.coef_
            mrss=mean_squared_error(label,data_pred)
else:
    for a in num_list:
        data_var=data[a,:]
        data_var=data_var.T
        data_lnr=lnr()
        data_lnr.fit(data_var,label)
        data_pred=data_lnr.predict(data_var)
        r2_score=data_lnr.score(data_var,label)
        if minr2<r2_score:
            minr2=r2_score
            minfea=a
            coef=data_lnr.coef_
            mrss=mean_squared_error(label,data_pred)
    return minr2,minfea,coef,mrss
#####
##
def linear_sf(data,label,num_list):
    data_var=data[num_list,:]
    data_var=data_var.T
    data_lnr=lnr()
    data_lnr.fit(data_var,label)
    data_pred=data_lnr.predict(data_var)
    r2_score=data_lnr.score(data_var,label)
    coef=data_lnr.coef_
    mrss=mean_squared_error(label,data_pred)
    return r2_score,coef,mrss
#####
###
data,label=fun.data_clas()
data_r2,data_coef,data_mse,data_pred=fun.linear(data,label)
for a in (range(len(data))):

```



```

plt.figure(a)
data_var=data[a]
data_var.shape=(211,1)
# plt.plot(data_var,data_pred[a])
# plt.plot(data_var,label,'o')
##### 2 #####
minr2list=list()
minfealist=list()
coeflist=list()
mrsslist=list()
adr2list=list()
for a in range (1,6):
    num_list=fun.ehaustive(a)
    minr2,minfea,coef,mrss=fun.linear_ex(data,label,num_list)
    minr2list.append(minr2)
    minfealist.append(minfea)
    coeflist.append(coef)
    mrsslist.append(mrss)
for r in range(len(minr2list)):
    adr2=minr2list[r]-(len(minfealist[r])-1)/(211-len(minfealist[r]))*(1-minr2list[r])
    adr2list.append(adr2)
#####
sfsr2,sfsr2in,sfs_inlist,sfs_r2=list(),list(),list(),list()
sfs_coef,sfs_mrss,sfsadr2list=list(),list(),list()
for a in range(7):
    sfsr2.append(a)
for times in range(5):
    sfr2=0
    for a in sfsr2:
        sfsr2in.append(a)
        num_list=np.asarray(sfsr2in)
        r2,coef1,mrss1=fun.linear_sf(data,label,num_list)
        if sfr2<r2:
            minin=a
            sfr2=r2
            coef=coef1
            mrss=mrss1
        sfsr2in.remove(a)
    sfsr2in.append(minin)
    sfsr2.remove(minin)
    sfs_inlist.append(np.asarray(sfsr2in))
    sfs_r2.append(sfr2)
    sfs_coef.append(coef)
    sfs_mrss.append(mrss)
for h in range(len(sfs_r2)):
    sfsadr2=sfs_r2[h]-(len(sfs_inlist[h])-1)/(211-len(sfs_inlist[h]))*(1-sfs_r2[h])

```

```

sfsadr2list.append(sfsadr2)
##### 3 #####
alpha=[50, 30, 15, 7, 3, 1, 0.30, 0.10, 0.03, 0.01]
alpha1=[-0.1,-0.2,-0.3,-0.4,-0.5,-0.6,-0.7,-0.7,-0.8,-0.9]
clf_list,lasso_list=list(),list()
for a in alpha:
    clf = Ridge(alpha=a)
    clf.fit(data.T, label)
    clf_list.append(clf.coef_)
for b in alpha:
    lasso = linear_model.Lasso(alpha=b)
    lasso.fit(data.T,label)
    lasso_list.append(lasso.coef_)
plt.figure(1)
plt.plot(alpha,clf_list)
plt.figure(2)
plt.plot(-1*np.log(alpha),lasso_list)

#!/usr/bin/env python3
# -*- coding: utf-8 -*-
"""

```

Created on Wed Dec 13 20:31:51 2017

```

@author: jianfengsong
"""

import xlrd as xl
import numpy as np
import matplotlib.pyplot as plt
import plotly.plotly as py
import plotly.figure_factory as ff
import pandas as pd
import plotly
import operator
from keras.applications.vgg16 import VGG16
from keras.preprocessing import image
from keras.applications.vgg16 import preprocess_input
from keras.models import Model
from itertools import combinations
from sklearn.svm import SVC
from sklearn.multiclass import OneVsOneClassifier

class fun():
    def excel_data(n):
        data=list()
        excel=xl.open_workbook(n)
        data_table=excel.sheet_by_index(0)

```

```

rows=data_table.nrows
cols=data_table.ncols
for a in range(rows):
    data.append(data_table.row_values(a))
return data
#####
##
def traindata():
    data=fun.excel_data('micrograph.xlsm')
    label=['spheroidite','network','pearlite','spheroidite+widmanstatten']
    data_train=list()
#    data_sample=list()
    index=list()
    index.append(0)
    for a in label:
        times=0
        if a is 'spheroidite+widmanstatten':
            for b in range(1,len(data)):
                if data[b][9] == a:
                    if times < 60:
                        data_train.append(data[b])
                        index.append(b)
                        times+=1
        else:
            for b in range(1,len(data)):
                if data[b][9]== a:
                    if times <100:
                        data_train.append(data[b])
                        index.append(b)
                        times+=1
    data_sample=np.delete(data,index,axis=0)
    return np.asarray(data_train),np.asarray(data_sample)
#####
##
def isfloat(value):
    try:
        float(value)
        return float(value)
    except:
        return value
#####
##
def data():
    datatrain,datasam=fun.traindata()
    index=[0,2,4,7,8]
    temp=list()

```

```

temptrain_list=list()
tempsam_list=list()
for a in range(len(datatrain.T)):
    if a in index:
        for b in range(len(datatrain.T[a])):
            temp.append(fun.isfloat(datatrain.T[a][b]))
        temptrain_list.append(temp)
        temp=list()
    else:
        temptrain_list.append(datatrain.T[a])
for a in range(len(datasam.T)):
    if a in index:
        for b in range(len(datasam.T[a])):
            temp.append(fun.isfloat(datasam.T[a][b]))
        tempsam_list.append(temp)
        temp=list()
    else:
        tempsam_list.append(datasam.T[a])
return tempsam_list,temptrain_list
#####
##
def vg16(path):
    img_path = 'Micrograph/' + path
    img = image.load_img(img_path)
    img=img.crop((0,0,645,484))
    x = image.img_to_array(img)
    x = np.expand_dims(x, axis=0)
    x = preprocess_input(x)
    return x
#####
##
def avg(matrix):
    div=matrix.shape[1]*matrix.shape[2]
    matrix=np.sum(matrix,axis=1)
    matrix=np.sum(matrix,axis=1)
    matrix=np.divide(matrix,div)
    matrix.shape=(matrix.shape[1],1)
    return (matrix)
#####
##
def diffea(train1,label,a):
    sph,net,pea,sphw=[],[],[],[]
    sph1,net1,peal,sphw1=[],[],[],[]
    total,total_lab=[],[]
    svm,svmlab=[],[]
    for x in range (0,99):

```

```

        sph.append(train1[x])
        sphl.append(label[x])
    for x in range (100,199):
        net.append(train1[x])
        netl.append(label[x])
    for x in range (200,299):
        pea.append(train1[x])
        peal.append(label[x])
    for x in range (300,359):
        sphw.append(train1[x])
        sphwl.append(label[x])
    total.append(sph);total.append(net);total.append(pea);total.append(sphw);

total_lab.append(sphl);total_lab.append(netl);total_lab.append(peal);total_lab.append(sphwl);
for b in total[a[0]]:
    svm.append(b)
for b in total[a[1]]:
    svm.append(b)
for b in total_lab[a[0]]:
    svmlab.append(b)
for b in total_lab[a[1]]:
    svmlab.append(b)
return svm,svmlab
#####
##
datatest,datatrain=fun.data()
model=VGG16(include_top=False,weights='imagenet',input_tensor=None,input_shape=(484,64
5,3),pooling=None)
model_1= Model(inputs=model.input, outputs=model.get_layer('block1_pool').output)
model_2= Model(inputs=model.input, outputs=model.get_layer('block2_pool').output)
model_3= Model(inputs=model.input, outputs=model.get_layer('block3_pool').output)
model_4= Model(inputs=model.input, outputs=model.get_layer('block4_pool').output)
train1_fea,test1_fea=list(),list()
train2_fea,test2_fea=list(),list()
train3_fea,test3_fea=list(),list()
train4_fea,test4_fea=list(),list()
train5_fea,test5_fea=list(),list()
train_lab,test_lab=list(),list()
layer=[1,2,3,4,5]
for a in range(len(datatrain[1])):
    vgg_16=fun.vg16(datatrain[1][a])
    train1_fea.append(model_1.predict(vgg_16))
    train2_fea.append(model_2.predict(vgg_16))
    train3_fea.append(model_3.predict(vgg_16))
    train4_fea.append(model_4.predict(vgg_16))
    train5_fea.append(model.predict(vgg_16))

```

```

train_lab.append(datatrain[9][a])
for a in range(len(datatest[1])):
    vgg_16_test=fun.vg16(datatest[1][a])
    test1_fea.append(model_1.predict(vgg_16_test))
    test2_fea.append(model_2.predict(vgg_16_test))
    test3_fea.append(model_3.predict(vgg_16_test))
    test4_fea.append(model_4.predict(vgg_16_test))
    test5_fea.append(model.predict(vgg_16_test))
    test_lab.append(datatest[9][a])
for a in range (len(train1_fea)):
    train1_fea[a]=fun.avg(train1_fea[a])
    train2_fea[a]=fun.avg(train2_fea[a])
    train3_fea[a]=fun.avg(train3_fea[a])
    train4_fea[a]=fun.avg(train4_fea[a])
    train5_fea[a]=fun.avg(train5_fea[a])
for a in range (len(test1_fea)):
    test1_fea[a]=fun.avg(test1_fea[a])
    test2_fea[a]=fun.avg(test2_fea[a])
    test3_fea[a]=fun.avg(test3_fea[a])
    test4_fea[a]=fun.avg(test4_fea[a])
    test5_fea[a]=fun.avg(test5_fea[a])
c42label=np.asarray(list(combinations(range(4),2)))
train,test=list(),list()
train.append((train1_fea,train2_fea,train3_fea,train3_fea,train4_fea,train5_fea))
test.append(test1_fea,test2_fea,test3_fea,test4_fea,test5_fea)
score=[]
for a in train[0]:
    for b in c42label:
        svm,svmlab=fun.diffea(a,train_lab,b)
        svm=np.array(svm).reshape(len(svm),len(svm[0]))
        clf=NuSVC()
        scores=np.mean(cross_val_score(clf,svm,svmlab,cv=10))
        score.append(1-scores)
train5_fea=np.array(train5_fea).reshape(len(train5_fea),len(train5_fea[0]))
lay5_ovo= OneVsOneClassifier(NuSVC()).fit(train5_fea,train_lab)

```

```
#!/usr/bin/env python3
```

```
# -*- coding: utf-8 -*-
```

```
"""
```

```
Created on Fri Dec 15 22:17:34 2017
```

```
@author: jianfengsong
```

```
"""
```

```

import xlrd as xl
import numpy as np
import matplotlib.pyplot as plt
import plotly.plotly as py
import plotly.figure_factory as ff
import pandas as pd
import plotly
import operator
from keras.applications.vgg16 import VGG16
from keras.preprocessing import image
from keras.applications.vgg16 import preprocess_input
from keras.models import Model
from itertools import combinations
from sklearn.svm import SVC
from sklearn.multiclass import OneVsOneClassifier
train1_fea,test1_fea=list(),list()
train2_fea,test2_fea=list(),list()
train3_fea,test3_fea=list(),list()
train4_fea,test4_fea=list(),list()
train5_fea,test5_fea=list(),list()
train_lab,test_lab=list(),list()
mar=list();ps=list();pw=list()
ax =['spheroidite','network','pearlite','spheroidite+widmanstatten']
for a in ax:

#    print(b[4].shape)
    if a == 'spheroidite+widmanstatten':
        for d in range(0,60):
            train5_fea.append(data_features[a][d][5])
            train_lab.append(a)
    else:
        for d in range(0,100):
            train5_fea.append(data_features[a][d][5])
            train_lab.append(a)
train5_fea=np.array(train5_fea).reshape(len(train5_fea),512)
lay5_ovo= OneVsOneClassifier(SVC()).fit(train5_fea,train_lab)
for d in range(0,36):
    mar.append(data_features_rest['martensite'][d][5])
mar=np.array(mar).reshape(len(mar),512)
mar_lab=lay5_ovo.predict(mar)
for d in range(0,107):
    ps.append(data_features_rest['pearlite+spheroidite'][d][5])
ps=np.array(ps).reshape(len(ps),512)
ps_lab=lay5_ovo.predict(ps)
for d in range(0,27):
    pw.append(data_features_rest['pearlite+widmanstatten'][d][5])

```

```
pw=np.array(pw).reshape(len(pw),512)
pw_lab=lay5_ovo.predict(pw)
```

```
#
#
#
#
#
```