8D_Solution

April 10, 2022

0.1 Task-D: Collinear features and their effect on linear models

[1]:
```
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")
import pandas as pd
import numpy as np
from sklearn.datasets import load_iris
from sklearn.linear_model import SGDClassifier
from sklearn.model_selection import GridSearchCV
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.linear_model import LogisticRegression
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score
```

[2]:
```
data = pd.read_csv('task_d.csv')
```

[3]:
```
data.head()
```

[3]:
```
          x         y         z       x*x       2*y  2*z+3*x*x         w  \
0 -0.581066  0.841837 -1.012978 -0.604025  0.841837  -0.665927 -0.536277
1 -0.894309 -0.207835 -1.012978 -0.883052 -0.207835  -0.917054 -0.522364
2 -1.207552  0.212034 -1.082312 -1.150918  0.212034  -1.166507  0.205738
3 -1.364174  0.002099 -0.943643 -1.280666  0.002099  -1.266540 -0.665720
4 -0.737687  1.051772 -1.012978 -0.744934  1.051772  -0.792746 -0.735054

   target
0       0
1       0
2       0
3       0
4       0
```

[4]:
```
X = data.drop(['target'], axis=1).values
Y = data['target'].values
```

0.2 Task 1 : Logistic Regression

1. **Finding the Correlation between the features**

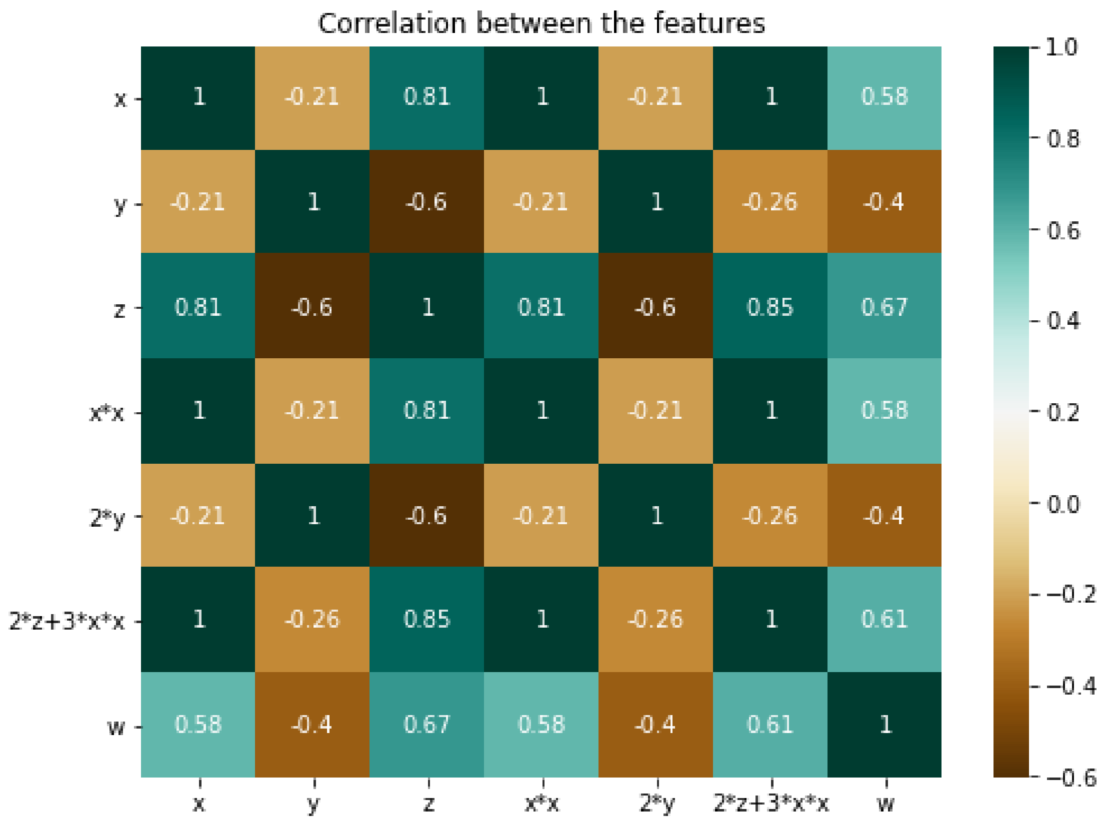
[5]:
```
corr = data[data.columns[:-1]].corr()
corr
```

[5]:
```
                 x         y         z       x*x       2*y  2*z+3*x*x  \
x         1.000000 -0.205926  0.812458  0.997947 -0.205926   0.996252
y        -0.205926  1.000000 -0.602663 -0.209289  1.000000  -0.261123
z         0.812458 -0.602663  1.000000  0.807137 -0.602663   0.847163
x*x       0.997947 -0.209289  0.807137  1.000000 -0.209289   0.997457
2*y      -0.205926  1.000000 -0.602663 -0.209289  1.000000  -0.261123
2*z+3*x*x  0.996252 -0.261123  0.847163  0.997457 -0.261123   1.000000
w         0.583277 -0.401790  0.674486  0.583803 -0.401790   0.606860

                 w
x         0.583277
y        -0.401790
z         0.674486
x*x       0.583803
2*y      -0.401790
2*z+3*x*x  0.606860
w         1.000000
```

[6]:
```
plt.figure(figsize=(8,6))
plt.title("Correlation between the features")
sns.heatmap(corr,cmap="BrBG",annot = True)
```

[6]:
```
<AxesSubplot:title={'center':'Correlation between the features'}>
```



2. Finding the best model for the given data

[7]:
```python
alpha = np.logspace(-5,8,10)
print("Alpha values:",alpha)
param_grid={'C':alpha}
```

```
Alpha values: [1.00000000e-05 2.78255940e-04 7.74263683e-03 2.15443469e-01
 5.99484250e+00 1.66810054e+02 4.64158883e+03 1.29154967e+05
 3.59381366e+06 1.00000000e+08]
```

[8]:
```python
LR = LogisticRegression(max_iter=10000, tol=0.1, random_state = 0)
LR = GridSearchCV(LR,param_grid,cv=5)
LR.fit(X,Y)
print("Best alpha is :",LR.best_params_['C'])
```

```
Best alpha is : 1e-05
```

3. Getting the weights with the original data

[9]:
```python
best_model = LogisticRegression(max_iter=10000, tol=0.1,C=1e-05,random_state =
 ↪0)
best_model.fit(X,Y)
```

```
acc = best_model.score(X,Y)
print("Accuracy of the model is {}%".format(acc*100))
```

```
Accuracy of the model is 100.0%
```

[10]:
```
weight = best_model.coef_[0]
print("Weights =",weight)
```

```
Weights = [ 0.0003637  -0.00034492  0.00048441  0.00035935 -0.00034492
0.0003819
  0.00032049]
```

4. Modifying original data

[11]:
```
X_New = np.random.normal(0,10**-2,X.shape)
best_model1 = LogisticRegression(max_iter=10000, tol=0.1,C=1e-05,random_state =␣
↪0)
best_model1.fit(X_New,Y)

acc1 = best_model1.score(X_New,Y)
print("Accuracy of the model with noise is {}%".format(acc1*100))
```

```
Accuracy of the model with noise is 62.0%
```

[12]:
```
weight1 = best_model1.coef_
print("Weights =",weight1)
```

```
Weights = [[-1.03721910e-08  1.24072634e-06 -1.97814951e-07 -1.38853930e-07
  -5.89260746e-07 -6.96008720e-07  1.37269248e-07]]
```

5. Checking deviations in metric and weights

[13]:
```
acc_diff = abs(acc - acc1)
print("Difference in Accuracy : {}%".format(np.round(acc_diff*100)))

weight_diff = abs(weight-weight1)
print("Difference in weights:",weight_diff)

weight_diff_per = weight_diff * 100
print("percentage Difference in weights:",weight_diff_per)
```

```
Difference in Accuracy : 38.0%
Difference in weights: [[0.00036371 0.00034616 0.00048461 0.00035949 0.00034433
0.0003826
  0.00032035]]
percentage Difference in weights: [[0.03637143 0.03461645 0.04846054 0.0359488
0.03443345 0.03825971
  0.03203492]]
```

[14]:
```
top4 = np.argsort(-weight_diff_per)[:,:4]
features = data.columns
print("Top 4 features are :",features[top4])
```

```
Top 4 features are : [['z' '2*z+3*x*x' 'x' 'x*x']]
```

0.3 Task2 : Linear SVM

1.Finding the best SVM model for the given data

[17]:
```
alpha_svm =  np.logspace(-5, 8, 10)
print("Alphas = ",alpha_svm)
param_grid={'C':alpha_svm}
svm = SVC(kernel="linear",random_state = 0)
```

```
Alphas =  [1.00000000e-05 2.78255940e-04 7.74263683e-03 2.15443469e-01
 5.99484250e+00 1.66810054e+02 4.64158883e+03 1.29154967e+05
 3.59381366e+06 1.00000000e+08]
```

[16]:
```
model_svm = GridSearchCV(svm, param_grid, cv=5)
model_svm.fit(X,Y)
print("Best alpha is:",model_svm.best_params_['C'])
```

```
Best alpha is: 0.007742636826811269
```

2.Getting the weights with the original data

[18]:
```
best_model_svm=SVC(kernel='linear',C=0.007742636826811269,random_state=0)
best_model_svm.fit(X,Y)

acc_svm = best_model_svm.score(X,Y)
print("Accuracy of the model is {}%".format(acc_svm*100))
```

```
Accuracy of the model is 100.0%
```

[19]:
```
weight_svm = best_model_svm.coef_
print("Weights =",weight_svm)
```

```
Weights = [[ 0.16056222 -0.20788705  0.32826166  0.14998082 -0.20788705
0.17461587
   0.13401176]]
```

3.Modifying original data

[20]:
```
X_New_svm = X + np.random.normal(0,10**-2,X.shape)
best_model_svm = SVC(kernel='linear',C=0.007742636826811269,random_state=0)
best_model_svm.fit(X_New_svm,Y)

acc1_svm = best_model_svm.score(X_New_svm,Y)
print("Accuracy of the model is {}%".format(acc1_svm*100))
```

```
Accuracy of the model is 100.0%
```

[21]:

```python
weight1_svm = best_model_svm.coef_
print("Weights =",weight1_svm)
```

```
Weights = [[ 0.16112764 -0.20612367  0.32858142  0.15085447 -0.20595574
0.17495079
   0.13471504]]
```

4.Checking deviations in metric and weights

[22]:

```python
acc_diff_svm = abs(acc1_svm - acc_svm)
print("Difference in Accuracy : {}%".format(np.round(acc_diff_svm*100)))

weight_diff_svm = abs(weight1_svm - weight_svm)
print("Difference in weights:",weight_diff_svm)

weight_diff_per_svm = weight_diff_svm * 100
print("Percentage difference in weights",weight_diff_per_svm)

top4_svm = np.argsort(-weight_diff_per_svm)[:,:4]
features = data.columns
print("Top 4 features are:",features[top4_svm])
```

```
Difference in Accuracy : 0.0%
Difference in weights: [[0.00056542 0.00176338 0.00031976 0.00087365 0.00193131
0.00033492
  0.00070329]]
Percentage difference in weights [[0.05654215 0.17633837 0.03197599 0.08736534
0.19313099 0.03349245
  0.07032868]]
Top 4 features are: [['2*y' 'y' 'x*x' 'w']]
```

0.4 Observations :

- Multi-collinearity doesnot affect both Logistic regression and Linear SVM.
- In case of Logistic Regression when we add the noise, the accuracy of the model is decreased.
- Noise does not affect the accuracy of Linear SVM model.