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

In [326…

```
%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.linear_model import LogisticRegression
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import accuracy_score
from sklearn.svm import SVC
import seaborn as sns
import matplotlib.pyplot as plt
```

In [327…

```
data = pd.read_csv('task_d.csv')
```

In [328…

```
data.head()
```

Out[328…

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

In [329…

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

Doing perturbation test to check the presence of collinearity

Task: 1 Logistic Regression

```
1. Finding the Correlation between the features
    a. check the correlation between the features
    b. plot heat map of correlation matrix using seaborn heatmap
2. Finding the best model for the given data
    a. Train Logistic regression on data(X,Y) that we have created in the above cell
    b. Find the best hyper prameter alpha with hyper parameter tuning using k-fold cross validation
(grid search CV or
    random search CV make sure you choose the alpha in log space)
    c. Creat a new Logistic regression with the best alpha
    (search for how to get the best hyper parameter value), name the best model as 'best_model'

3. Getting the weights with the original data
    a. train the 'best_model' with X, Y
    b. Check the accuracy of the model 'best_model_accuracy'
    c. Get the weights W using best_model.coef_

4. Modifying original data
    a. Add a noise(order of 10^-2) to each element of X
    and get the new data set X' (X' = X + e)
    b. Train the same 'best_model' with data (X', Y)
    c. Check the accuracy of the model 'best_model_accuracy_edited'
    d. Get the weights W' using best_model.coef_

5.  Checking deviations in metric and weights
    a. find the difference between 'best_model_accuracy_edited' and 'best_model_accuracy'
    b. find the absolute change between each value of W and W' ==> |(W-W')|
    c. print the top 4 features which have higher % change in weights
    compare to the other feature
```

Task: 2 Linear SVM

```
1. Do the same steps (2, 3, 4, 5) we have done in the above task 1.
```

Do write the observations based on the results you get from the deviations of weights in both Logistic Regression and linear SVM

Logistic Regression

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

In [330…

```
correlation = data.drop(['target'], axis=1).corr()
```

In [331…

```
correlation
```

Out[331…

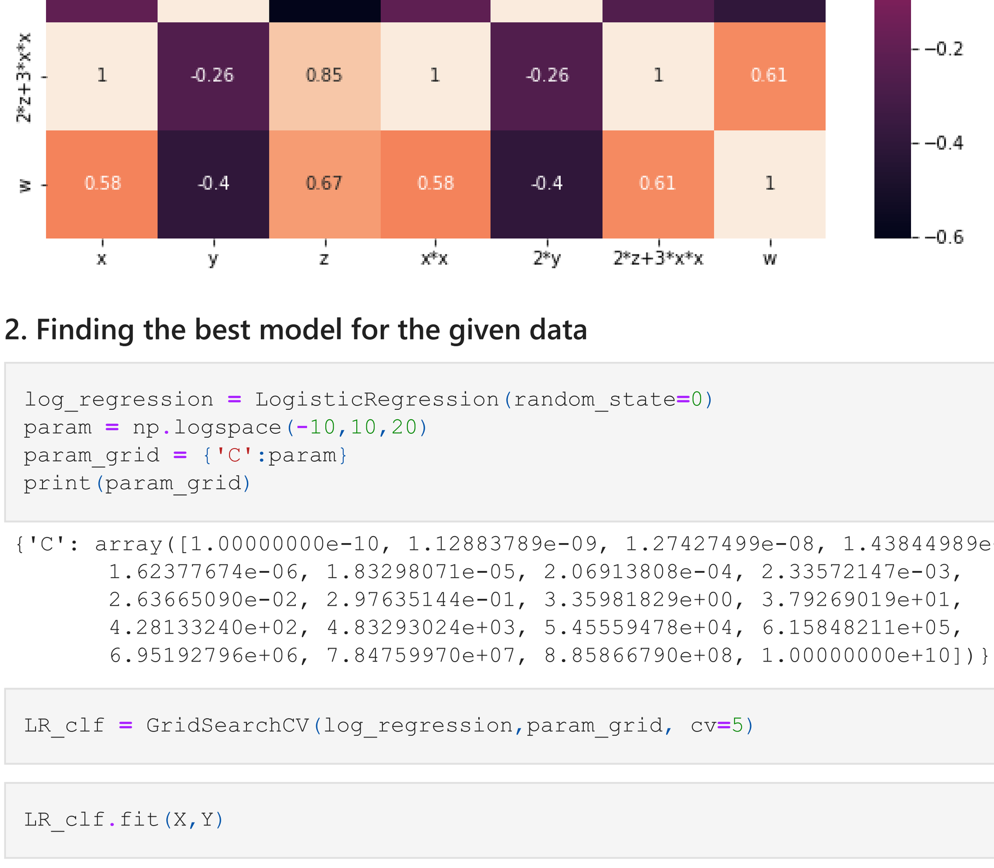
	x	y	z	x*x	2*y	2*z+3*x*x	w
x	1.000000	-0.205926	0.812458	0.997947	-0.205926	0.996252	0.583277
y	-0.205926	1.000000	-0.602663	-0.209289	1.000000	-0.261123	-0.401790
z	0.812458	-0.602663	1.000000	0.807137	-0.602663	0.847163	0.674486
x*x	0.997947	-0.209289	0.807137	1.000000	-0.209289	0.997457	0.583803
2*y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

In [332…

```
plt.figure(figsize=(10,8))
plt.title("Correlation between features")
sns.heatmap(correlation, xticklabels = True, yticklabels = True , annot= True)
```

Out[332…

```
<AxesSubplot:title={'center':'Correlation between features'}>
```



2. Finding the best model for the given data

In [333…

```
log_regression = LogisticRegression(random_state=0)
param = np.logspace(-10,10,20)
param_grid = {'C':param}
print(param_grid)
```

```
{'C': array([1.00000000e-10, 1.12883789e-09, 1.27427499e-08, 1.43844989e-07,
       1.62377674e-06, 1.83298071e-05, 2.06913808e-04, 2.33572147e-03,
       2.63665090e-02, 2.97635144e-01, 3.35981829e+00, 3.79269019e+01,
       4.28133240e+02, 4.83293024e+03, 5.45559478e+04, 6.15848211e+05,
       6.95192796e+06, 7.84759970e+07, 8.85866790e+08, 1.00000000e+10])}
```

In [334…

```
LR_clf = GridSearchCV(log_regression,param_grid, cv=5)
```

In [335…

```
LR_clf.fit(X,Y)
```

Out[335…

```
GridSearchCV(cv=5, estimator=LogisticRegression(random_state=0),
             param_grid={'C': array([1.00000000e-10, 1.12883789e-09, 1.27427499e-08, 1.43844989e-07,
       1.62377674e-06, 1.83298071e-05, 2.06913808e-04, 2.33572147e-03,
       2.63665090e-02, 2.97635144e-01, 3.35981829e+00, 3.79269019e+01,
       4.28133240e+02, 4.83293024e+03, 5.45559478e+04, 6.15848211e+05,
       6.95192796e+06, 7.84759970e+07, 8.85866790e+08, 1.00000000e+10])})
```

In [336…

```
LR_clf.best_params_
```

Out[336…

```
{'C': 1e-10}
```

3. Getting the weights with the original data

In [337…

```
best_model = LogisticRegression(C=1e-10, random_state = 0)
best_model.fit(X,Y)
predicted_values = best_model.predict(X)
```

In [338…

```
best_model_accuracy = accuracy_score(predicted_values,Y)
print(best_model_accuracy)
```

```
1.0
```

In [339…

```
weights = best_model.coef_[0]
print(weights)
```

```
[ 3.64145071e-09 -3.45342165e-09  4.84995111e-09  3.59784968e-09
 -3.45342165e-09  3.82364313e-09  3.20875164e-09]
```

1. **Modifying original data**

In [340…

```
X_new = X + 10**-2
```

In [341…

```
best_model_edited = best_model.fit(X_new,Y)
predicted_values_edited = best_model.predict(X)
```

In [342…

```
best_model_accuracy_edited = accuracy_score(predicted_values_edited,Y)
print(best_model_accuracy_edited)
```

```
1.0
```

In [343…

```
weights_edited = best_model_edited.coef_[0]
print(weights_edited)
```

```
[ 3.64145070e-09 -3.45342164e-09  4.84995109e-09  3.59784967e-09
 -3.45342164e-09  3.82364312e-09  3.20875163e-09]
```

1. **Checking deviations in metric and weights**

In [344…

```
print("Difference between accuracy of best_model and best_model_edited is: \n{}".format(best_model_accuracy-bes
```

```
Difference between accuracy of best_model and best_model_edited is:
0.0
```

In [345…

```
abs_difference = abs(weights-weights_edited)
print("Absolute difference between accuracy of best_model and best_model_edited is: \n{}".format(abs_difference
```

```
Absolute difference between accuracy of best_model and best_model_edited is:
[1.12721006e-17 1.06900562e-17 1.50130113e-17 1.11371370e-17
 1.06900562e-17 1.18360744e-17 9.93268140e-18]
```

In [346…

```
n=len(weights)
percent_change=[]
for i in range(n):
    percent_change.append(((abs_difference[i]/(abs(weights[i])))*100))      #percent change = (x2-x1/x1)*100
```

In [347…

```
percent_change
```

Out[347…

```
[3.0954972457091706e-07,
 3.0954969676079734e-07,
 3.095497453303721e-07,
 3.0954981501337034e-07,
 3.0954969676079734e-07,
 3.095496635388072e-07,
 3.0954971001124375e-07]
```

In [348…

```
features = data.columns.values[:-1]
```

In [349…

```
sort_index = np.argsort(percent_change)
sort_index=sort_index[:2:-1]    #Getting top 4 indices
```

In [350…

```
sort_index
```

Out[350…

```
array([3, 2, 0, 6], dtype=int64)
```

In [351…

```
print("top 4 features which have higher % change in weights are:")
for j in sort_index:
    print(features[j])
```

```
top 4 features which have higher % change in weights are:
x*x
z
x
w
```

Task: 2 Linear SVM

2. Finding the best model for the given data

In [352…

```
svm = SVC(kernel='linear', random_state = 0)
print(param_grid)
```

```
{'C': array([1.00000000e-10, 1.12883789e-09, 1.27427499e-08, 1.43844989e-07,
       1.62377674e-06, 1.83298071e-05, 2.06913808e-04, 2.33572147e-03,
       2.63665090e-02, 2.97635144e-01, 3.35981829e+00, 3.79269019e+01,
       4.28133240e+02, 4.83293024e+03, 5.45559478e+04, 6.15848211e+05,
       6.95192796e+06, 7.84759970e+07, 8.85866790e+08, 1.00000000e+10])}
```

In [353…

```
SVM_clf = GridSearchCV(svm,param_grid, cv=5)
```

In [354…

```
SVM_clf.fit(X,Y)
```

Out[354…

```
GridSearchCV(cv=5, estimator=SVC(kernel='linear', random_state=0),
             param_grid={'C': array([1.00000000e-10, 1.12883789e-09, 1.27427499e-08, 1.43844989e-07,
       1.62377674e-06, 1.83298071e-05, 2.06913808e-04, 2.33572147e-03,
       2.63665090e-02, 2.97635144e-01, 3.35981829e+00, 3.79269019e+01,
       4.28133240e+02, 4.83293024e+03, 5.45559478e+04, 6.15848211e+05,
       6.95192796e+06, 7.84759970e+07, 8.85866790e+08, 1.00000000e+10])})
```

In [355…

```
SVM_clf.best_params_
```

Out[355…

```
{'C': 0.026366508987303555}
```

3. Getting the weights with the original data

In [356…

```
best_model = SVC(C=0.026366508987303555, kernel='linear', random_state = 0)
best_model.fit(X,Y)
predicted_values = best_model.predict(X)
```

In [357…

```
best_model_accuracy = accuracy_score(predicted_values,Y)
print(best_model_accuracy)
```

```
1.0
```

In [358…

```
weights = best_model.coef_[0]
print(weights)
```

```
[ 0.16883905 -0.24906502  0.48486823  0.15792086 -0.24906502  0.20066943
  0.14301976]
```

1. **Modifying original data**

In [359…

```
best_model_edited = best_model.fit(X_new,Y)
predicted_values_edited = best_model.predict(X)
```

In [360…

```
best_model_accuracy_edited = accuracy_score(predicted_values_edited,Y)
print(best_model_accuracy_edited)
```

```
1.0
```

In [361…

```
weights_edited = best_model_edited.coef_[0]
print(weights_edited)
```

```
[ 0.16883905 -0.24906503  0.48486823  0.15792086 -0.24906503  0.20066943
  0.14301975]
```

1. **Checking deviations in metric and weights**

In [362…

```
print("Difference between accuracy of best_model and best_model_edited is: \n{}".format(best_model_accuracy-bes
```

```
Difference between accuracy of best_model and best_model_edited is:
0.0
```

In [363…

```
abs_difference = abs(weights-weights_edited)
print("Absolute difference between accuracy of best_model and best_model_edited is: \n{}".format(abs_difference
```

```
Absolute difference between accuracy of best_model and best_model_edited is:
[1.61718852e-09 3.07965140e-09 2.96370656e-09 8.56852894e-10
 3.07965140e-09 1.12899040e-09 6.67971711e-09]
```

In [364…

```
n=len(weights)
percent_change=[]
for i in range(n):
    percent_change.append((abs_difference[i]/abs(weights[i]))*100)      #percent change = x2-x1/x1
```

In [365…

```
percent_change
```

Out[365…

```
[9.57828505532657e-07,
 1.2364848951726265e-06,
 6.112395823338648e-07,
 5.425837174517666e-07,
 1.2364848951726265e-06,
 5.626120451915128e-07,
 4.670485423457468e-06]
```

In [366…

```
sort_index = np.argsort(percent_change)
sort_index=sort_index[:2:-1]    #Getting top 4 indices
```

In [367…

```
sort_index
```

Out[367…

```
array([6, 4, 1, 0], dtype=int64)
```

In [368…

```
print("top 4 features which have higher % change in weights are:")
for j in sort_index:
    print(features[j])
```

```
top 4 features which have higher % change in weights are:
w
2*y
y
x
```

Observations:

1. Some features in our dataset is highly correlated as per the correlation matrix
2. After the pertubation test, weights of Logistic Regression and SVM only have a very small change in weights. So, the features are not collinear