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

In [ ]:

```
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")
import pandas as pd
import numpy as np
from sklearn.linear_model import SGDClassifier
from sklearn.model_selection import GridSearchCV
from sklearn import model_selection
import seaborn as sns
import matplotlib.pyplot as plt
```

In [ ]:

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remo
unt, call drive.mount("/content/drive", force_remount=True).
```

In [ ]:

```
data = pd.read_csv('/content/drive/MyDrive/task_d.csv')
```

In [ ]:

```
data.head()
```

Out[ ]:

	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 [ ]:

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

In [ ]:

```
data.shape
```

Out[ ]:

```
(100, 8)
```

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 usin
g 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

In [ ]:

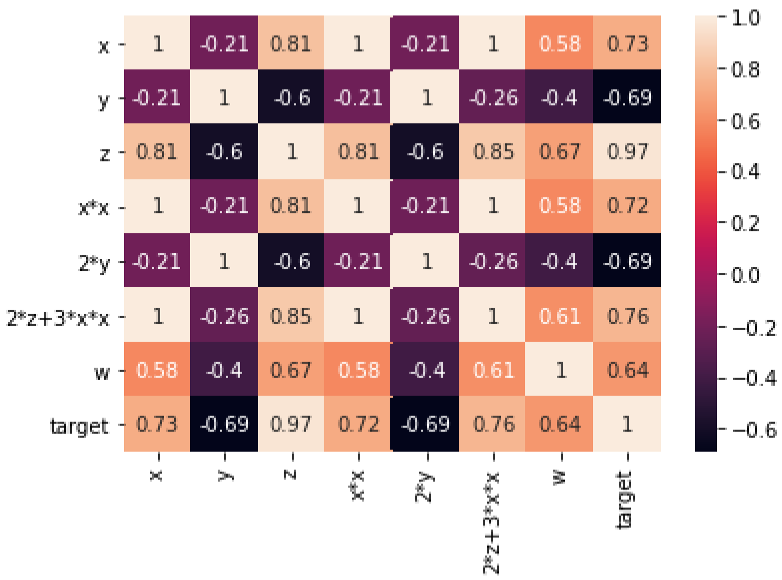
```
# correlation between features
data.corr()
```

Out[ ]:

	x	y	z	x*x	2*y	2*z+3*x*x	w	targ
x	1.000000	-0.205926	0.812458	0.997947	-0.205926	0.996252	0.583277	0.7282
y	-0.205926	1.000000	-0.602663	-0.209289	1.000000	-0.261123	-0.401790	-0.6906
z	0.812458	-0.602663	1.000000	0.807137	-0.602663	0.847163	0.674486	0.9699
x*x	0.997947	-0.209289	0.807137	1.000000	-0.209289	0.997457	0.583803	0.7195
2*y	-0.205926	1.000000	-0.602663	-0.209289	1.000000	-0.261123	-0.401790	-0.6906
2*z+3*x*x	0.996252	-0.261123	0.847163	0.997457	-0.261123	1.000000	0.606860	0.7647
w	0.583277	-0.401790	0.674486	0.583803	-0.401790	0.606860	1.000000	0.6417
target	0.728290	-0.690684	0.969990	0.719570	-0.690684	0.764729	0.641750	1.0000

In [ ]:

```
sns.heatmap(data.corr(), annot=True)
plt.show()
```



In [ ]:

```
# Create regularization penalty space
penalty = ['l1', 'l2']

# Create regularization hyperparameter space
alpha = np.logspace(0, 4, 10)

# Create hyperparameter options
hyperparameters = dict(alpha=alpha, penalty=penalty)
```

In [ ]:

```
logistic = SGDClassifier(loss='log')
```

In [ ]:

```
clf = GridSearchCV(logistic, hyperparameters, cv=5, verbose=0)
```

In [ ]:

```
model = clf.fit(X,Y)
```

In [ ]:

```
best_alpha = model.best_estimator_.get_params()['alpha']
best_penalty = model.best_estimator_.get_params()['penalty']
```

In [ ]:

```
best_alpha, best_penalty
```

Out[ ]:

```
(1.0, 'l2')
```

In [ ]:

```
best_model_logistic = SGDClassifier(loss='log', alpha=best_alpha, penalty=best_p
enalty)
```

In [ ]:

```
best_model_logistic.fit(X, Y)
best_model_logistic_coeff = best_model_logistic.coef_
```

In [ ]:

```
best_model_logistic_coeff
```

Out[ ]:

```
array([[ 0.17103812, -0.18616907,  0.25967448,  0.16714711, -0.18616
907,
         0.18178501,  0.15083884]])
```

In [ ]:

```
scoring = 'accuracy'
kfold = model_selection.KFold(n_splits=10, random_state=7, shuffle=True)
results = model_selection.cross_val_score(best_model_logistic, X, Y, cv=kfold, s
coring=scoring)
print("Accuracy: %.3f (%.3f)" % (results.mean(), results.std()))
```

```
Accuracy: 1.000 (0.000)
```

1. 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*

In [ ]:

```
new_x = X
new_y = Y
```

In [ ]:

```
# adding 10^-2 to all elements of X
row = len(new_x)
col = len(new_x[0])

for r in range(row):
  for c in range(col):
    new_x[r][c] = new_x[r][c] +  (1/100)
```

In [ ]:

```
# Train the same 'best_model' with data (X', Y)
best_model_logistic.fit(new_x, Y)
```

Out[ ]:

```
SGDClassifier(alpha=1.0, average=False, class_weight=None, early_sto
pping=False,
              epsilon=0.1, eta0=0.0, fit_intercept=True, l1_ratio=0.
15,
              learning_rate='optimal', loss='log', max_iter=1000,
              n_iter_no_change=5, n_jobs=None, penalty='l2', power_t
=0.5,
              random_state=None, shuffle=True, tol=0.001,
              validation_fraction=0.1, verbose=0, warm_start=False)
```

In [ ]:

```
# Check the accuracy of the model 'best_model_accuracy_edited'
scoring = 'accuracy'
kfold = model_selection.KFold(n_splits=10, random_state=7, shuffle=True)
results_edited = model_selection.cross_val_score(best_model_logistic, new_x, Y,
cv=kfold, scoring=scoring)
print("Accuracy: %.3f (%.3f)" % (results_edited.mean(), results_edited.std()))
```

```
Accuracy: 1.000 (0.000)
```

In [ ]:

```
best_model_coef_edited = best_model_logistic.coef_
```

In [ ]:

```
#find the absolute change between each value of W and W' ==> |(W-W')|
feature_diff = abs(best_model_logistic_coeff - best_model_logistic.coef_)
feature_diff
```

Out[ ]:

```
array([[0.00236173, 0.00170221, 0.001378  , 0.00267454, 0.00170221,
        0.00258543, 0.00128529]])
```

In [ ]:

```
# find the difference between 'best_model_accuracy_edited' and 'best_model_accur
acy'
results - results_edited
```

Out[ ]:

```
array([0., 0., 0., 0., 0., 0., 0., 0., 0., 0.])
```

In [ ]:

```
# print the top 4 features which have higher % change in weights compare to the
 other feature
feature_diff
sorted_feature_index= np.argsort(feature_diff)
```

In [ ]:

```
count = 0
print ("top 4 features which have higher % change in weights compare to the othe
r feature: \n")
for i in sorted_feature_index[0]:
  count += 1
  print (data.columns[i])
  if count ==4 :
    break
```

```
top 4 features which have higher % change in weights compare to the
other feature:

w
z
y
2*y
```

Task 2 Linear SVM

1. 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'
2. 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*
3. 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*
4. 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

In [ ]:

```
# Create regularization penalty space
penalty = ['l1', 'l2']

# Create regularization hyperparameter space
alpha = np.logspace(0, 4, 10)

# Create hyperparameter options
hyperparameters = dict(alpha=alpha, penalty=penalty)

svm = SGDClassifier(loss='hinge')

clf = GridSearchCV(svm, hyperparameters, cv=5, verbose=0)
model = clf.fit(X,Y)

best_alpha = model.best_estimator_.get_params()['alpha']
best_penalty = model.best_estimator_.get_params()['penalty']
```

In [ ]:

```
best_alpha, best_penalty
```

Out[ ]:

```
(1.0, 'l2')
```

In [ ]:

```
best_model_svm = SGDClassifier(loss='hinge', alpha=best_alpha, penalty=best_pena
lty)

best_model_svm.fit(X, Y)
```

Out[ ]:

```
SGDClassifier(alpha=1.0, average=False, class_weight=None, early_sto
pping=False,
              epsilon=0.1, eta0=0.0, fit_intercept=True, l1_ratio=0.
15,
              learning_rate='optimal', loss='hinge', max_iter=1000,
              n_iter_no_change=5, n_jobs=None, penalty='l2', power_t
=0.5,
              random_state=None, shuffle=True, tol=0.001,
              validation_fraction=0.1, verbose=0, warm_start=False)
```

In [ ]:

```
best_model_svm_coeff = best_model_svm.coef_
best_model_svm_coeff
```

Out[ ]:

```
array([[ 0.16735403, -0.22421524,  0.35738663,  0.15886585, -0.22421
524,
         0.1861288 ,  0.13003009]])
```

In [ ]:

```
scoring = 'accuracy'
kfold = model_selection.KFold(n_splits=10, random_state=7, shuffle=True)
results = model_selection.cross_val_score(best_model_svm, X, Y, cv=kfold, scorin
g=scoring)
print("Accuracy: %.3f (%.3f)" % (results.mean(), results.std()))
```

```
Accuracy: 1.000 (0.000)
```

In [ ]:

```
new_x = X
new_y = Y

# adding 10^-2 to all elements of X
row = len(new_x)
col = len(new_x[0])

for r in range(row):
  for c in range(col):
    new_x[r][c] = new_x[r][c] +  (1/100)
```

In [ ]:

```
# Train the same 'best_model' with data (X', Y)
best_model_svm.fit(new_x, Y)
```

Out[ ]:

```
SGDClassifier(alpha=1.0, average=False, class_weight=None, early_sto
pping=False,
              epsilon=0.1, eta0=0.0, fit_intercept=True, l1_ratio=0.
15,
              learning_rate='optimal', loss='hinge', max_iter=1000,
              n_iter_no_change=5, n_jobs=None, penalty='l2', power_t
=0.5,
              random_state=None, shuffle=True, tol=0.001,
              validation_fraction=0.1, verbose=0, warm_start=False)
```

In [ ]:

```
# Check the accuracy of the model 'best_model_accuracy_edited'
scoring = 'accuracy'
kfold = model_selection.KFold(n_splits=10, random_state=7, shuffle=True)
results_edited = model_selection.cross_val_score(best_model_svm, new_x, Y, cv=kf
old, scoring=scoring)
print("Accuracy: %.3f (%.3f)" % (results_edited.mean(), results_edited.std()))
```

```
Accuracy: 1.000 (0.000)
```

In [ ]:

```
best_model_svm_coef_edited = best_model_svm.coef_
best_model_svm_coef_edited
```

Out[ ]:

```
array([[ 0.16043829, -0.22168292,  0.35836363,  0.15000505, -0.22168
292,
         0.17826821,  0.13986965]])
```

In [ ]:

```
#find the absolute change between each value of W and W' ==> |(W-W')|
feature_diff = abs(best_model_svm_coeff - best_model_svm.coef_)
feature_diff
```

Out[ ]:

```
array([[0.00691574, 0.00253232, 0.000977  , 0.0088608 , 0.00253232,
        0.00786058, 0.00983956]])
```

In [ ]:

```
# find the difference between 'best_model_accuracy_edited' and 'best_model_accur
acy'
results - results_edited
```

Out[ ]:

```
array([0., 0., 0., 0., 0., 0., 0., 0., 0., 0.])
```

In [ ]:

```
# print the top 4 features which have higher % change in weights compare to the
 other feature
feature_diff
sorted_feature_index= np.argsort(feature_diff)



count = 0
print ("top 4 features which have higher % change in weights compare to the othe
r feature: \n")
for i in sorted_feature_index[0]:
  count += 1
  print (data.columns[i])
  if count ==4 :
    break
```

```
top 4 features which have higher % change in weights compare to the
other feature:

z
y
2*y
x
```

Before and after adding noise to data, accuracy is same.

top 4 features which have higher % change is weight compare to other features, almost same.