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

In [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,LogisticRegression
from sklearn.model_selection import GridSearchCV
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.metrics import confusion_matrix
from sklearn.svm import SVC
```

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

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

Out[3]:

	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 [4]:
```
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

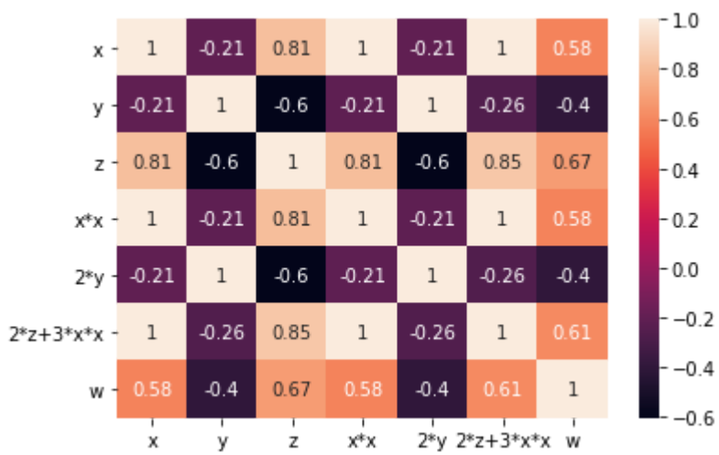
In [5]:
```
## Task 1 - Logistic regression

#Task 1.1
#Find Correlation between the feature
corr = data.drop(['target'], axis=1).corr()
corr
```

Out[5]:

	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 [6]:
```
sns.heatmap(corr,annot=True)
```

Out[6]: `<matplotlib.axes._subplots.AxesSubplot at 0x22b072f7a08>`



HeatMap Results

X highly correlated with x*x,z,2*z+3*x*x,w
Y highly correlated with y*y

In [7]:
```
#Task 1.2
logistic = LogisticRegression()
alpha_values = np.logspace(-1, 2, 20)
params_logReg = {
   'C':alpha_values

}

gridsearchcv_logistic = GridSearchCV(estimator=logistic,param_grid=params_logReg,cv=3,
                                n_jobs=-1)
```

In [8]:
```
gridsearchcv_logistic.fit(X,Y)
```

Out[8]:
```
GridSearchCV(cv=3, error_score=nan,
             estimator=LogisticRegression(C=1.0, class_weight=None, dual=False,
                                          fit_intercept=True,
                                          intercept_scaling=1, l1_ratio=None,
                                          max_iter=100, multi_class='auto',
                                          n_jobs=None, penalty='l2',
                                          random_state=None, solver='lbfgs',
                                          tol=0.0001, verbose=0,
                                          warm_start=False),
             iid='deprecated', n_jobs=-1,
             param_grid={'C': array([  0.1       ,   0.14384499,   0.20691381,   0.29763514,
          0.42813324,   0.61584821,   0.88586679,   1.27427499,
          1.83298071,   2.6366509 ,   3.79269019,   5.45559478,
          7.8475997 ,  11.28837892,  16.23776739,  23.35721469,
         33.59818286,  48.32930239,  69.51927962, 100.        ])},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring=None, verbose=0)
```

In [9]:
```
gridsearchcv_logistic.best_params_
```

Out[9]:
```
{'C': 0.1}
```

In [10]:
```
best_model = LogisticRegression(C=0.1)
best_model.fit(X,Y)
```

Out[10]:
```
LogisticRegression(C=0.1, class_weight=None, dual=False, fit_intercept=True,
                   intercept_scaling=1, l1_ratio=None, max_iter=100,
                   multi_class='auto', n_jobs=None, penalty='l2',
                   random_state=None, solver='lbfgs', tol=0.0001, verbose=0,
                   warm_start=False)
```

In [11]:
```
#Task 1.3
best_model_accuracy = best_model.score(X,Y)
coeff  = best_model.coef_
print('Best Accuracy score ', best_model_accuracy)
print('Coefficient value ')

df_coeff =pd.DataFrame(data=coeff,columns=corr.columns).T
df_coeff.rename(columns={0:'Coefficient'},inplace=True)
print(df_coeff)
```

```
Best Accuracy score  1.0
Coefficient value
           Coefficient
x             0.413398
y            -0.515531
z             0.784972
x*x           0.393928
2*y          -0.515531
2*z+3*x*x     0.449310
w             0.346586
```

In [15]:
```
#Task 1.4 Modifying original data
e = 10^-2
X_1  = X+e
new_X = pd.DataFrame(data=X_1,columns=corr.columns)
best_model = LogisticRegression(C=0.1)
best_model.fit(X_1,Y)

best_model_accuracy_edited = best_model.score(X_1,Y)
coeff_edited  = best_model.coef_
print('Best Accuracy score ', best_model_accuracy_edited)
print('Coefficient value ')

df_coeff =pd.DataFrame(data=coeff,columns=corr.columns).T
df_coeff.rename(columns={0:'Coefficient'},inplace=True)
print(df_coeff)
```

```
Best Accuracy score  1.0
Coefficient value
          Coefficient
x            0.413398
y           -0.515531
z            0.784972
x*x          0.393928
2*y         -0.515531
2*z+3*x*x    0.449310
w            0.346586
```

In [17]:
```
new_X.head()
```

. . .

In [19]:
```
sns.heatmap(new_X.corr(),annot=True)
```

. . .

In [20]:
```
#Task 1.5
#a. find the difference between 'best_model_accuracy_edited' and 'best_model_accuracy'
diff_bw_Acc_EditedAcc  = best_model_accuracy - best_model_accuracy_edited
coeff_diff= abs(coeff  - coeff_edited)

print('difference between best_model_accuracy_edited and best_model_accuracy',diff_bw_Acc_EditedAcc)
print('Absolute change between each value of W and W ==> |(W-W_edited)| is ',coeff_diff)
```

```
difference between best_model_accuracy_edited and best_model_accuracy 0.0
Absolute change between each value of W and W ==> |(W-W_edited)| is  [[1.79151290e-07 1.56177357e-06 2.07320916e-06 6.41658346e-07
  1.56177357e-06 1.33175770e-06 2.55010118e-06]]
```

In [21]:
```
coeff_diff
```

Out[21]:
```
array([[1.79151290e-07, 1.56177357e-06, 2.07320916e-06, 6.41658346e-07,
        1.56177357e-06, 1.33175770e-06, 2.55010118e-06]])
```

In [22]:
```
df_coeff_higherchange =pd.DataFrame(data=coeff_diff,columns=corr.columns).T
df_coeff_higherchange.rename(columns={0:'Coefficient_diff'},inplace=True)
print(df_coeff_higherchange)
```

```
          Coefficient_diff
x                 1.791513e-07
y                 1.561774e-06
z                 2.073209e-06
x*x               6.416583e-07
2*y               1.561774e-06
2*z+3*x*x         1.331758e-06
w                 2.550101e-06
```

In [31]:
```
df_coeff_higherchange.sort_values(by='Coefficient_diff',axis=0,ascending=False)[:5]
```

Out[31]:

	Coefficient_diff
w	0.000003
z	0.000002
y	0.000002
2*y	0.000002
2*z+3*x*x	0.000001

Adding noise , not impacted the weight the much.

Task 2. SVM

In [32]:
```
#Task 2.2
SVM = SVC(kernel='linear')
alpha_values = np.logspace(-1, 2, 20)
params_logReg = {
   'C':alpha_values

}

gridsearchcv_SVM = GridSearchCV(estimator=SVM,param_grid=params_logReg,cv=3,
                                n_jobs=-1)

gridsearchcv_SVM.fit(X,Y)

gridsearchcv_SVM.best_params_

best_model = SVC(C=0.1,kernel='linear')
best_model.fit(X,Y)

#Task 2.3
best_model_accuracy = best_model.score(X,Y)
coeff  = best_model.coef_
print('Best Accuracy score ', best_model_accuracy)
print('Coefficient value ')

df_coeff =pd.DataFrame(data=coeff,columns=corr.columns).T
df_coeff.rename(columns={0:'Coefficient'},inplace=True)
print(df_coeff)

#Task 2.4 Modifying original data
e = 10^-2
X_1  = X+e
best_model = SVC(C=0.1,kernel='linear')
best_model.fit(X_1,Y)

best_model_accuracy_edited = best_model.score(X_1,Y)
coeff_edited  = best_model.coef_
print('Best Accuracy score ', best_model_accuracy_edited)
print('Coefficient value ')

df_coeff =pd.DataFrame(data=coeff,columns=corr.columns).T
df_coeff.rename(columns={0:'Coefficient'},inplace=True)
print(df_coeff)
```

```
#Task 2.5
#a. find the difference between 'best_model_accuracy_edited' and 'best_model_accuracy'
diff_bw_Acc_EditedAcc  = best_model_accuracy - best_model_accuracy_edited
coeff_diff= abs(coeff  - coeff_edited)

print('difference between best_model_accuracy_edited and best_model_accuracy',diff_bw_Acc_EditedAcc)
print('Absolute change between each value of W and W ==> |(W-W_edited)| is ',coeff_diff)

coeff_diff

df_coeff_higherchange =pd.DataFrame(data=coeff_diff,columns=corr.columns).T
df_coeff_higherchange.rename(columns={0:'Coefficient_diff'},inplace=True)
print(df_coeff_higherchange)

df_coeff_higherchange.sort_values(by='Coefficient_diff',axis=0,ascending=False)[:5]
```

```
Best Accuracy score  1.0
Coefficient value
          Coefficient
x            0.206086
y           -0.295112
z            0.667505
x*x          0.186201
2*y         -0.295112
2*z+3*x*x    0.248172
w            0.096677
Best Accuracy score  1.0
Coefficient value
          Coefficient
x            0.206086
y           -0.295112
z            0.667505
x*x          0.186201
2*y         -0.295112
2*z+3*x*x    0.248172
w            0.096677
difference between best_model_accuracy_edited and best_model_accuracy 0.0
Absolute change between each value of W and W ==> |(W-W_edited)| is  [[2.60790197e-05 6.46749470e-04 3.12952705e-04 1.87272274e-05
  6.46749470e-04 2.09287813e-05 5.57059935e-04]]
          Coefficient_diff
x                 0.000026
y                 0.000647
z                 0.000313
```

```
x*x                 0.000019
2*y                 0.000647
2*z+3*x*x           0.000021
w                   0.000557
```

Out[32]:

	Coefficient_diff
y	0.000647
2*y	0.000647
w	0.000557
z	0.000313
x	0.000026

Compare to logistic adding noise which slightly weight is changed , but acuraccy doesn't impacted.

In [ ]: