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

In [9]:
```
%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
```

In [10]:
```
data = pd.read_csv('task_d.csv')
```

In [11]:
```
data.head()
```

Out[11]:

	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 [12]:
```
X = data.drop(['target'], axis=1)
Y = data['target']
```

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

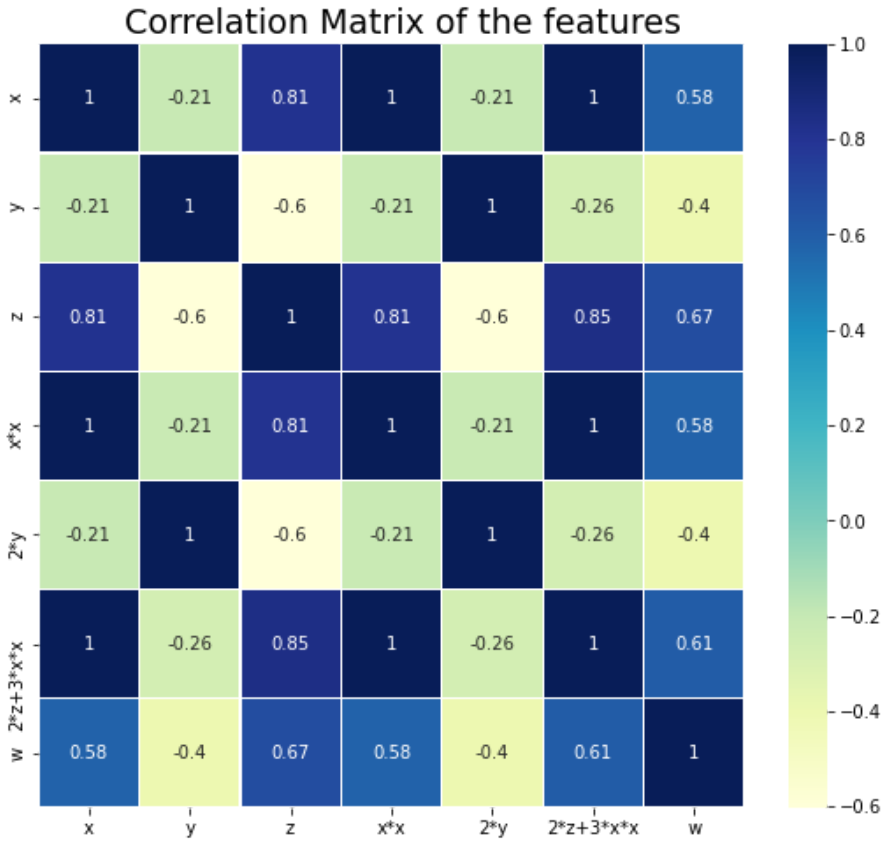
1. Do the same steps (2, 3, 4, 5) we have done in the above task 1.

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

In [14]:
```
z = data.drop(['target'], axis=1)

corrmat = z.corr()

f, ax = plt.subplots(figsize =(9, 8))
sns.heatmap(corrmat, ax = ax, cmap ="YlGnBu", linewidths = 0.1,annot=True)
plt.title("  Correlation Matrix of the features",fontsize=19)
plt.show()
```



In [29]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X.values,Y.values, test_size=0.3, random_state=0)
```

In [42]:
```
param_grid = {'alpha':[0.0001*pow(10,i) for i in range(8)]}
lin_svc_lg = SGDClassifier(loss='log',random_state = True)
grid = GridSearchCV(lin_svc_lg, param_grid=param_grid,cv=3)
grid.fit(X_train ,y_train)
grid.best_params_
```

```
{'alpha': 0.01}
```

Out[42]:

In [43]:
```
best_model = SGDClassifier(loss='log', alpha = 0.01,random_state = True)
best_model.fit(X_train,y_train)
accuracy = best_model.score(X_test,y_test)
print(f'Accuracy is {accuracy*100}%')
```

```
Accuracy is 100.0%
```

In [50]:
```
#perturbation testing
index = []

clf_lor = SGDClassifier(loss='log', alpha = 0.01,random_state = True)
clf_lor.fit(X_train, y_train)
w1=clf_lor.coef_


X_train_add=X_train + 0.01

clf_lor.fit(X_train_add, y_train)
w2=clf_lor.coef_


change_w= np.abs(((w1-w2)/w1)*100)

w_change=[]
for i in range(X_train.shape[1]):
  w_change.append(change_w[0,i])

top_4_weight = sorted(w_change, reverse =True)[:4]
print(f'the top 4 features which have higher % change in weights compare to the other feature are:')
for i in  top_4_weight:
  print(f'{i} for {column_name[w_change.index(i)]}')
```

```
the top 4 features which have higher % change in weights compare to the other feature are:
0.11850400440689489 for x
0.09973964095686787 for x*x
0.07530220003179594 for 2*z+3*x*x
0.06180149379768311 for w
```

Observation

1. Change in weights define how much feature is collinear to other feature. After adding noise to feature and apply logistic regression . i have found feature 'x' is more colinear than other followed by 'xx' , '$2z+3xx$' and 'w'.

In [55]:
```
param_grid = {'alpha':[0.0001*pow(10,i) for i in range(8)]}
lin_svc_lg = SGDClassifier(loss='hinge',random_state = True)
grid = GridSearchCV(lin_svc_lg, param_grid=param_grid,cv=3)
grid.fit(X_train ,y_train)
grid.best_params_
```

Out[55]:
```
{'alpha': 1.0}
```

In [56]:
```
best_model = SGDClassifier(loss='hinge', alpha = 1,random_state = True)
best_model.fit(X_train,y_train)
accuracy = best_model.score(X_test,y_test)
print(f'Accuracy is {accuracy*100}%')
```

```
Accuracy is 100.0%
```

In [57]:
```
#perturbation testing
index = []

clf_svm = SGDClassifier(loss='hinge', alpha =1,random_state = True)
clf_svm.fit(X_train, y_train)
w1=clf_svm.coef_
```

```
X_train_add=X_train + 0.01

clf_svm.fit(X_train_add, y_train)
w2=clf_svm.coef_


change_w= np.abs(((w1-w2)/w1)*100)

w_change=[]
for i in range(X_train.shape[1]):
  w_change.append(change_w[0,i])


top_4_weight = sorted(w_change, reverse =True)[:4]
print(f'the top 4 features which have higher % change in weights compare to the other feature are:')
for i in  top_4_weight:
  print(f'{i} for {column_name[w_change.index(i)]}')
```

```
the top 4 features which have higher % change in weights compare to the other feature are:
1.3951005531383227 for w
1.1367710253258412 for x
1.1323283046063217 for x*x
0.8739062358557589 for 2*z+3*x*x
```

Observation

1. Change in weights define how much feature is collinear to other feature. After adding noise to feature and apply linear SVM . i have found feature 'w' is more colinear than other followed by 'x' , '$x*x$' *and* '$2z+3xx$'.