Homework 2: classification

Data source: http://archive.ics.uci.edu/ml/datasets/Polish+companies+bankruptcy+data **Description:** The goal of this HW is to be familiar with the basic classifiers PML Ch 3. For this HW, we continue to use Polish companies bankruptcy data Data Set from UCI Machine Learning Repository. Download the dataset and put the 4th year file (4year.arff) in your YOUR_GITHUB_ID/PHBS_MLF_2019/HW2/ I did a basic process of the data (loading to dataframe, creating bankruptcy column, changing column names, filling-in na values, training-vs-test split, standardizatino, etc). See my github。

Preparation

Load, read and clean

```
from scipy.io import arff
import pandas as pd
import numpy as np

data = arff.loadarff('./data/4year.arff')
df = pd.DataFrame(data[0])
df['bankruptcy'] = (df['class']==b'1')
del df['class']
df.columns = ['X{0:02d}'.format(k) for k in range(1,65)] + ['bankruptcy']
df.describe()
```

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.dataframe tbody tr th {
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}
```

	X01	X02	X03	X04	X05	X06	X07	X08
count	9791.000000	9791.000000	9791.000000	9749.000000	9.771000e+03	9791.000000	9791.000000	9773.000000
mean	0.043019	0.596404	0.130959	8.136600	6.465164e+01	-0.059273	0.059446	19.884016
std	0.359321	4.587122	4.559074	290.647281	1.475939e+04	6.812754	0.533344	698.697015
min	-12.458000	0.000000	-445.910000	-0.045319	-3.794600e+05	-486.820000	-12.458000	-1.848200
25%	0.001321	0.263145	0.020377	1.047000	-5.121700e+01	-0.000578	0.003004	0.428300
50%	0.041364	0.467740	0.199290	1.591800	-5.557600e-02	0.000000	0.048820	1.088700
75%	0.111130	0.689255	0.410670	2.880400	5.573200e+01	0.065322	0.126940	2.691000
max	20.482000	446.910000	22.769000	27146.000000	1.034100e+06	322.200000	38.618000	53209.000000

8 rows × 64 columns

```
sum(df.bankruptcy == True)
```

```
515
```

```
from sklearn.impute import SimpleImputer

imp_mean = SimpleImputer(missing_values=np.nan, strategy='mean')
X_imp = imp_mean.fit_transform(df.values)

```

A dll load error occured here. Solution recorded in my blog

```python
from sklearn.model_selection import train_test_split

X, y = X_imp[:, :-1], X_imp[:, -1]
X_train, X_test, y_train, y_test =\
    train_test_split(X, y,
                     test_size=0.3,
                     random_state=0,
                     stratify=y)
```

```python
from sklearn.preprocessing import StandardScaler

stdsc = StandardScaler()
X_train_std = stdsc.fit_transform(X_train)
X_test_std = stdsc.transform(X_test)
```

1. Find the 2 most important features

Select the 2 most important features using LogisticRegression with L1 penalty. **(Adjust C until you see 2 features)**

```python
from sklearn.linear_model import LogisticRegression

C = [1, .1, .01, 0.001]
cdf = pd.DataFrame()

for c in C:
    lr = LogisticRegression(penalty='l1', C=c, solver='liblinear',  random_state=0)
    lr.fit(X_train_std, y_train)
    print(f'[C={c}] with {lr.coef_[lr.coef_!=0].shape[0]} features: \n {lr.coef_[lr.coef_!=0]} \n') # Python >= 3.7
    if lr.coef_[lr.coef_!=0].shape[0] == 2:
        cdf = pd.DataFrame(lr.coef_.T , df.columns[:-1], columns=['coef'])
```

```
[C=1] with 41 features:
 [-0.21124721 -0.32721186 -0.027786   -1.13272997 -0.06357798  2.33195848
 -1.15522622 -0.00657024 -0.04684187 -1.08683927  0.1425248   0.01096755
 -0.01922072 -0.01383184 -0.01411706 -0.10736095  0.00238513  0.24577125
 -0.85510327  0.85209928 -0.30366778 -0.30474956 -0.0296142  -0.01749839
 -0.04401046 -0.03613927  0.12211322 -0.0138838  -0.45429792  1.3157471
 -0.4035633  -0.46000256  0.04269182 -0.13000407 -0.0474417  -0.11325886
 -0.12953285 -0.56454917  0.00689488 -0.4300807  -0.08949632]

[C=0.1] with 14 features:
 [-0.07260191 -0.00523502 -0.05866954 -0.1005855  -0.62441034 -0.04143727
 -0.07701467 -0.00230242  0.01202513  0.01090586  0.28007452 -0.10726656
 -0.04314757 -0.00208574]

[C=0.01] with 2 features:
 [-0.00174613 -0.05571114]

[C=0.001] with 0 features:
 []
```

```python
lr = LogisticRegression(penalty='l1', C=0.01, solver='liblinear',  random_state=0) # complete
lr.fit(X_train_std, y_train)
```

```
LogisticRegression(C=0.01, class_weight=None, dual=False, fit_intercept=True,
                   intercept_scaling=1, l1_ratio=None, max_iter=100,
                   multi_class='auto', n_jobs=None, penalty='l1',
                   random_state=0, solver='liblinear', tol=0.0001, verbose=0,
                   warm_start=False)
```

```python
cdf = cdf[cdf.coef != 0]
cdf
```

```css
.dataframe tbody tr th {
    vertical-align: top;
}

.dataframe thead th {
    text-align: right;
}
```

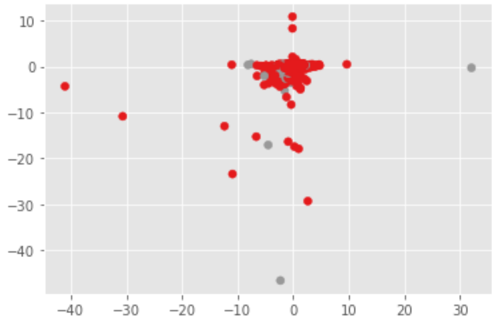
	coef
X01	-0.001746
X38	-0.055711

redefine X_train_std and X_test_std

```
X_train_std = X_train_std[:, lr.coef_[0]!=0]
X_test_std = X_test_std[:, lr.coef_[0]!=0]
```

```
from matplotlib.colors import ListedColormap
import matplotlib.pyplot as plt
plt.style.use('ggplot')
plt.scatter(x=X_train_std[:,0], y=X_train_std[:,1], c=y_train, cmap='Set1')
```

```
<matplotlib.collections.PathCollection at 0x21ee24bfcc8>
```

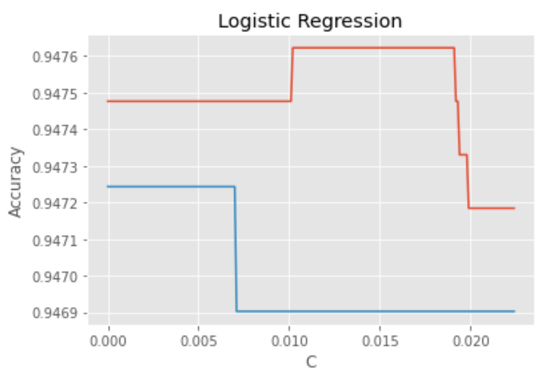


2. Apply LR / SVM / Decision Tree below

Using the 2 selected features, apply LR / SVM / decision tree. **Try your own hyperparameters (C, gamma, tree depth, etc)** to maximize the prediction accuracy. (Just try several values. You don't need to show your answer is the maximum.)

LR

```
CLr = np.arange(0.000000000000001, 0.0225, 0.0001)
acrcLr = [] # acurracy
for c in CLr:
    lr = LogisticRegression(C=c,penalty='l1',solver='liblinear')
    lr.fit(X_train_std, y_train)
    acrcLr.append([lr.score(X_train_std, y_train), lr.score(X_test_std, y_test), c])
acrcLr = np.array(acrcLr)
plt.plot(acrcLr[:,2], acrcLr[:,0])
plt.plot(acrcLr[:,2], acrcLr[:,1])
plt.xlabel('C')
plt.ylabel('Accuracy')
plt.title('Logistic Regression')
plt.show()
```



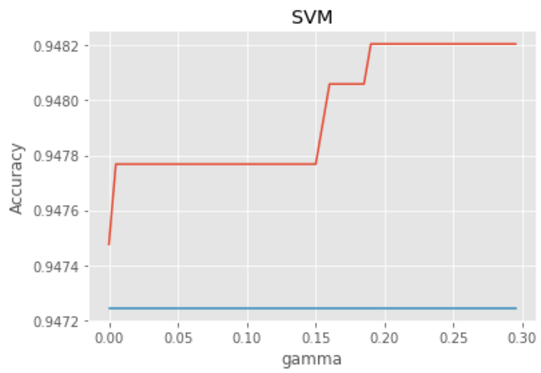
Choose `c=.01`

```
c = .01
lr = LogisticRegression(C=c,penalty='l1',solver='liblinear')
lr.fit(X_train_std, y_train)
print(f'Accuracy when [c={c}] \nTrain {lr.score(X_train_std, y_train)}\nTest  {lr.score(X_test_std, y_test)}')
```

```
Accuracy when [c=0.01]
Train 0.9474759264662971
Test  0.9469026548672567
```

SVM

```
from sklearn.svm import SVC
G = np.arange(0.00001, 0.3, 0.005)
acrcSvm = []
for g in G:
    svm = SVC(kernel='rbf', gamma=g, C=1.0, random_state=0)
    svm.fit(X_train_std, y_train)
    acrcSvm.append([svm.score(X_train_std, y_train), svm.score(X_test_std, y_test), g])
acrcSvm = np.array(acrcSvm)
plt.plot(acrcSvm[:,2], acrcSvm[:,0])
plt.plot(acrcSvm[:,2], acrcSvm[:,1])
plt.xlabel('gamma')
plt.ylabel('Accuracy')
plt.title('SVM')
plt.show()
```



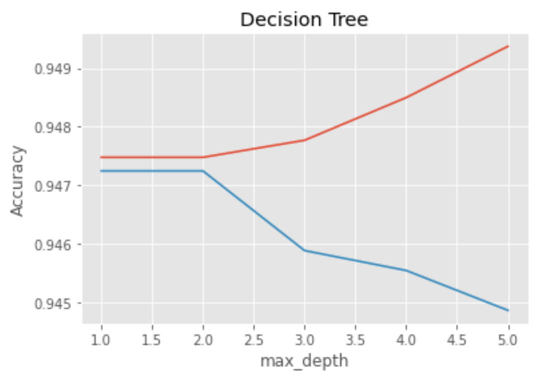
Choose `gamma = 0.2`

```
g = 0.2
svm = SVC(kernel='rbf', gamma=g, C=1.0, random_state=0)
svm.fit(X_train_std, y_train)
print(f'Accuracy when [gamma={g}] \nTrain {svm.score(X_train_std, y_train)}\nTest  {svm.score(X_test_std, y_test)}')
```

```
Accuracy when [gamma=0.2]
Train 0.9482054274875985
Test  0.9472430224642614
```

Decision Tree

```
from sklearn.tree import DecisionTreeClassifier
depthTree = range(1, 6)
acrcTree = []
for depth in depthTree:
    tree = DecisionTreeClassifier(criterion='gini', max_depth=depth, random_state=0)
    tree.fit(X_train_std, y_train)
    acrcTree.append([tree.score(X_train_std, y_train), tree.score(X_test_std, y_test), depth])
acrcTree = np.array(acrcTree)
plt.plot(acrcTree[:,2], acrcTree[:,0])
plt.plot(acrcTree[:,2], acrcTree[:,1])
plt.xlabel('max_depth')
plt.ylabel('Accuracy')
plt.title('Decision Tree')
plt.show()
```



Choose `max_depth=2`:

```
depth = 2
tree = DecisionTreeClassifier(criterion='gini', max_depth=depth, random_state=0)
tree.fit(X_train_std, y_train)
print(f'Accuracy when [max_depth={depth}] \nTrain {tree.score(X_train_std, y_train)}\nTest  {tree.score(X_test_std, y_test)}')
```

```
Accuracy when [max_depth=2]
Train 0.9474759264662971
Test  0.9472430224642614
```

3. Visualize the classification

Visualize your classifiers using the plot_decision_regions function from PML Ch. 3

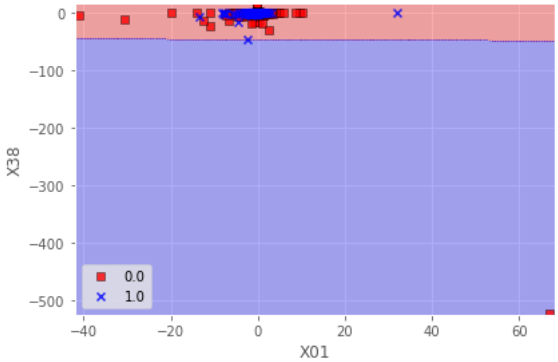
```
def plot_decision_regions(X, y, classifier, test_idx=None, resolution=0.02):

    # setup marker generator and color map
    markers = ('s', 'x', 'o', '^', 'v')
    colors = ('red', 'blue', 'lightgreen', 'gray', 'cyan')
    cmap = ListedColormap(colors[:len(np.unique(y))])

    # plot the decision surface
    x1_min, x1_max = X[:, 0].min() - 1, X[:, 0].max() + 1
    x2_min, x2_max = X[:, 1].min() - 1, X[:, 1].max() + 1
    xx1, xx2 = np.meshgrid(np.arange(x1_min, x1_max, resolution),
                           np.arange(x2_min, x2_max, resolution))
    Z = classifier.predict(np.array([xx1.ravel(), xx2.ravel()]).T)
    Z = Z.reshape(xx1.shape)
    plt.contourf(xx1, xx2, Z, alpha=0.3, cmap=cmap)
    plt.xlim(xx1.min(), xx1.max())
    plt.ylim(xx2.min(), xx2.max())

    for idx, cl in enumerate(np.unique(y)):
        plt.scatter(x=X[y == cl, 0],
                    y=X[y == cl, 1],
                    alpha=0.8,
                    c=colors[idx],
                    marker=markers[idx],
                    label=cl,
                    edgecolor='black')

    # highlight test samples
    if test_idx:
        # plot all samples
        X_test, y_test = X[test_idx, :], y[test_idx]

        plt.scatter(X_test[:, 0],
                    X_test[:, 1],
                    c='',
                    edgecolor='black',
                    alpha=1.0,
                    linewidth=1,
                    marker='o',
                    s=100,
                    label='test set')
```

```
X_combined_std = np.vstack((X_train_std, X_test_std))
y_combined = np.hstack((y_train, y_test))
```

LR

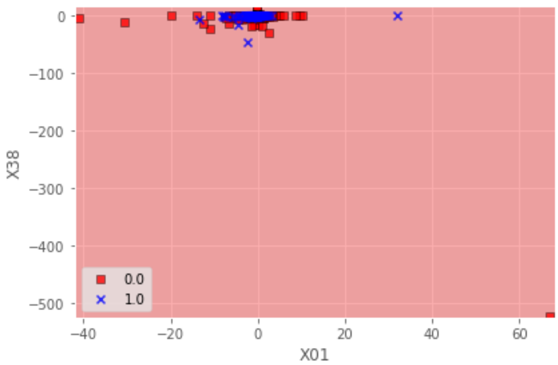
`test_idx` removed on purpose

```
plot_decision_regions(X=X_combined_std, y=y_combined,
                      classifier=lr)
plt.xlabel(cdf.index[0])
plt.ylabel(cdf.index[1])
plt.legend(loc='lower left')

plt.tight_layout()
#plt.savefig('images/03_01.png', dpi=300)
plt.show()
```



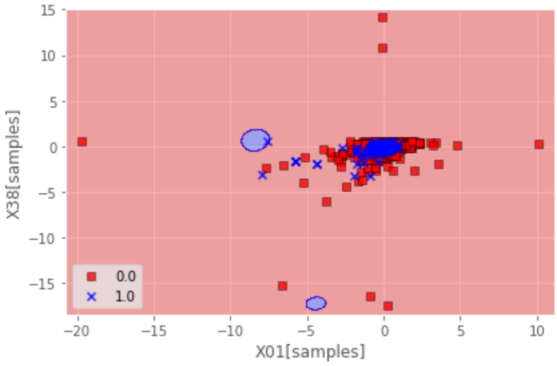
Decision Tree

```
plot_decision_regions(X=X_combined_std, y=y_combined,
                      classifier=tree)
plt.xlabel(cdf.index[0])
plt.ylabel(cdf.index[1])
plt.legend(loc='lower left')

plt.tight_layout()
#plt.savefig('images/03_01.png', dpi=300)
plt.show()
```



SVM (samples)

```
# Visualization of all features in a SVM model is too slow
# Because the complexity is very high (sourse:https://scikit-learn.org/stable/modules/svm.html#complexity)
# So use random samples(n=3000) instead

samples = np.random.randint(0, len(X_combined_std), size=3000)
plot_decision_regions(X=X_combined_std[samples], y=y_combined[samples],
                      classifier=svm)
plt.xlabel(cdf.index[0] + '[samples]')
plt.ylabel(cdf.index[1] + '[samples]')
plt.legend(loc='lower left')

plt.tight_layout()
#plt.savefig('images/03_01.png', dpi=300)
plt.show()
```




```

```