github repo: https://github.com/zheyanliu99/data-mining-hw3.git

Problem 2

In [ ]:
```
import numpy as np
from utils import random_normal_with_chi
from scipy.stats import chi2
```

b) & c)

Generate data using random_normal_with_chi in utils.py

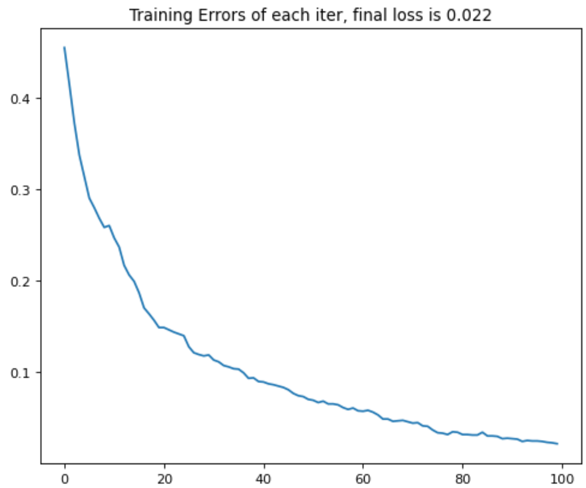
In [ ]:
```
X, y = random_normal_with_chi((2000, 10), chi2.ppf(q=0.5, df=10))
X_test, y_test = random_normal_with_chi((20000, 10), chi2.ppf(q=0.5, df=10))
```

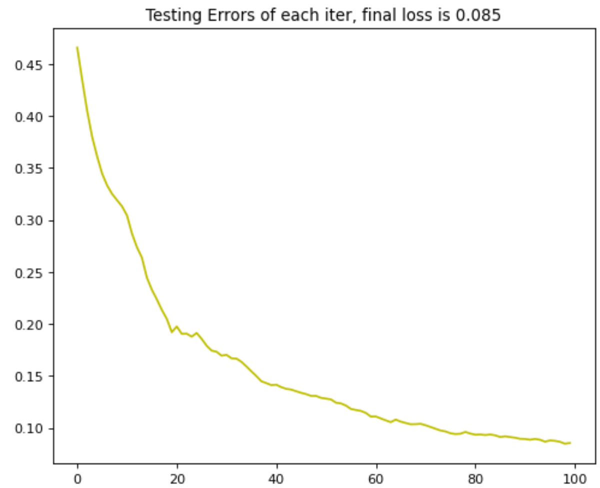
Fit AdaBoost

In [ ]:
```
from sklearn.ensemble import AdaBoostClassifier
from sklearn.datasets import make_classification
clf = AdaBoostClassifier(n_estimators=100, random_state=0)
clf.fit(X, y)
train_final_loss = 1 - clf.score(X, y)
test_final_loss = 1 - clf.score(X_test, y_test)
train_error_steps = [ 1-a for a in list(clf.staged_score(X, y))]
test_error_steps = [ 1-a for a in list(clf.staged_score(X_test, y_test))]
```

Plot errors of each iter

In [ ]:
```
import matplotlib.pyplot as plt
plt.figure(figsize=(16, 6), dpi=80)
plt.subplot(1,2,1)
plt.plot(train_error_steps)
plt.title(f"Training Errors of each iter, final loss is {np.round(train_final_l
plt.subplot(1,2,2)
plt.plot(test_error_steps, 'y')
plt.title(f"Testing Errors of each iter, final loss is {np.round(test_final_los
plt.show()
```





The training and testing error decrease as the increase of iter. After iter 20, the errors decrease much slower.

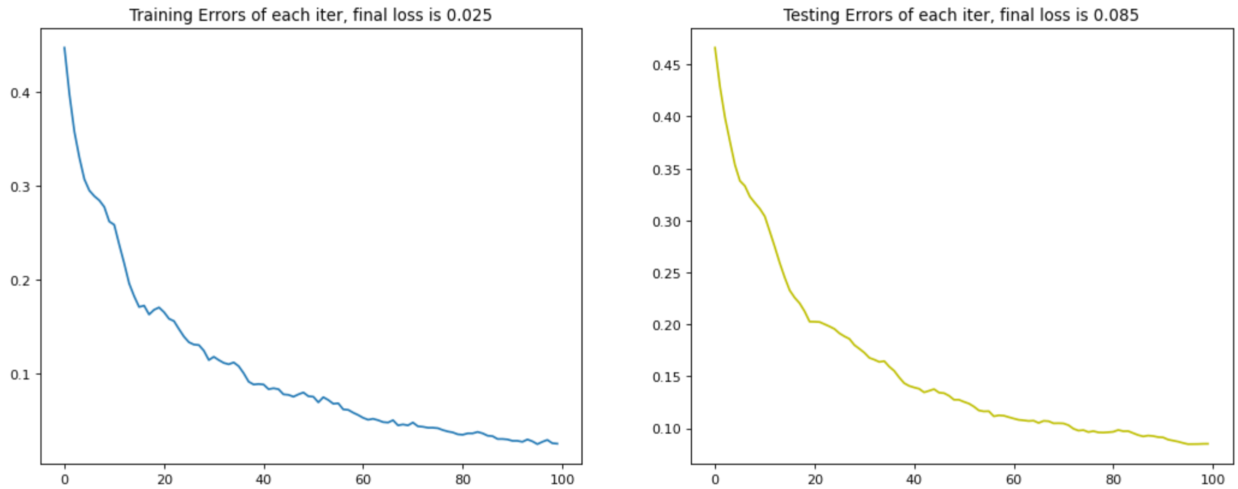
d)

Class 2

In [ ]:
```
X, y = random_normal_with_chi((2000, 10), 12)
X_test, y_test = random_normal_with_chi((20000, 10), 12)

from sklearn.ensemble import AdaBoostClassifier
from sklearn.datasets import make_classification
clf = AdaBoostClassifier(n_estimators=100, random_state=0)
clf.fit(X, y)
train_final_loss = 1 - clf.score(X, y)
test_final_loss = 1 - clf.score(X_test, y_test)
train_error_steps = [ 1-a for a in list(clf.staged_score(X, y))]
test_error_steps = [ 1-a for a in list(clf.staged_score(X_test, y_test))]

import matplotlib.pyplot as plt
plt.figure(figsize=(16, 6), dpi=80)
plt.subplot(1,2,1)
plt.plot(train_error_steps)
plt.title(f"Training Errors of each iter, final loss is {np.round(train_final_l
plt.subplot(1,2,2)
plt.plot(test_error_steps, 'y')
plt.title(f"Testing Errors of each iter, final loss is {np.round(test_final_los
plt.show()
```



Compared with Class 1, Class 2 final loss are lower on both the train and test set.

Problem 3

Read and split data to train and test

Data and model preparation

In [ ]:
```
import pandas as pd
from sklearn.model_selection import train_test_split
df = pd.read_csv('static/spam.csv')
X = df.drop('y',axis=1)
y = df['y']

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, randon
X_train = np.array(X_train)
X_test = np.array(X_test)
y_train = np.array(y_train)
y_test = np.array(y_test)
```

Standardlize data

In [ ]:
```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
X_train = sc.fit_transform(X_train)
```

Data loader

In [ ]:
```
import torch
from torch.utils.data import Dataset, DataLoader

class dataset(Dataset):
  def __init__(self,x,y):
    self.x = torch.tensor(x,dtype=torch.float32)
    self.y = torch.tensor(y,dtype=torch.float32)
    self.length = self.x.shape[0]
```

```
  def __getitem__(self,idx):
    return self.x[idx],self.y[idx]
  def __len__(self):
    return self.length
trainset = dataset(X_train, y_train)
#DataLoader
trainloader = DataLoader(trainset,batch_size=64,shuffle=False)
```

Neural Network for classification

In [ ]:
```
#defining the network
from torch import nn
from torch.nn import functional as F
class Net(nn.Module):
  def __init__(self,input_shape):
    super(Net,self).__init__()
    self.fc1 = nn.Linear(input_shape,32)
    self.fc2 = nn.Linear(32,64)
    self.fc3 = nn.Linear(64,1)
  def forward(self,x):
    x = torch.relu(self.fc1(x))
    x = torch.relu(self.fc2(x))
    x = torch.sigmoid(self.fc3(x))
    return x

# hyper parameters
learning_rate = 0.05
epochs = 90
# Model , Optimizer, Loss
model = Net(input_shape=X.shape[1])
optimizer = torch.optim.SGD(model.parameters(),lr=learning_rate)
loss_fn = nn.BCELoss()
```

Training

In [ ]:
```
from sklearn.metrics import accuracy_score

losses = []
accur = []
for i in range(epochs):
  for j,(x_train_batch,y_train_batch) in enumerate(trainloader):

    #calculate output
    output = model(x_train_batch)

    #calculate loss
    loss = loss_fn(output,y_train_batch.reshape(-1,1))

    #accuracy
    predicted = model(torch.tensor(X_train,dtype=torch.float32))
    acc = (predicted.reshape(-1).detach().numpy().round() == y_train).mean()
    #backprop
    optimizer.zero_grad()
    loss.backward()
    optimizer.step()

  if i%5 == 0:
```

```
    losses.append(loss)
    accur.append(acc)
    print("epoch {}\tloss : {}\t accuracy : {}".format(i,loss,acc))
```

```
epoch 0 loss : 0.6132799386978149        accuracy : 0.6733695652173913
epoch 5 loss : 0.24249491095542908       accuracy : 0.9347826086956522
epoch 10        loss : 0.18373772501945496       accuracy : 0.9456521739130435
epoch 15        loss : 0.15823718905448914       accuracy : 0.9480978260869565
epoch 20        loss : 0.13753348588943481       accuracy : 0.9513586956521739
epoch 25        loss : 0.12564696371555328       accuracy : 0.9543478260869566
epoch 30        loss : 0.11753439903259277       accuracy : 0.9576086956521739
epoch 35        loss : 0.11181149631738663       accuracy : 0.9592391304347826
epoch 40        loss : 0.10558822751045227       accuracy : 0.9619565217391305
epoch 45        loss : 0.10160228610038757       accuracy : 0.9644021739130435
epoch 50        loss : 0.09815233200788498       accuracy : 0.9668478260869565
epoch 55        loss : 0.09560005366802216       accuracy : 0.970108695652174
epoch 60        loss : 0.09282892197370529       accuracy : 0.9720108695652174
epoch 65        loss : 0.09040112793445587       accuracy : 0.9739130434782609
epoch 70        loss : 0.08750148117542267       accuracy : 0.9755434782608695
epoch 75        loss : 0.08679115027189255       accuracy : 0.9779891304347826
epoch 80        loss : 0.08642778545618057       accuracy : 0.9785326086956522
epoch 85        loss : 0.08352037519216537       accuracy : 0.9790760869565217
```

Testing

In [ ]:

```
from sklearn import metrics
X_test = sc.fit_transform(X_test)
predicted = model(torch.tensor(X_test,dtype=torch.float32))
predicted_np = predicted.reshape(-1).detach().numpy()

acc = (predicted_np.round() == y_test).mean()
fpr, tpr, thresholds = metrics.roc_curve(y_test, predicted_np)
auc_score = metrics.auc(fpr, tpr)
print("Accuracy {} AUC : {}".format(acc,auc_score,acc))
```

```
Accuracy 0.9359391965255157 AUC : 0.9796550913684705
```

Result

The performance of NN on the test set is better than tree in terms of AUC. However, the interpretability of the tree is much better.