hw2_liuke

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```
In [63]: import numpy
         from urllib.request import urlopen
         import scipy.optimize
         import random
         from math import exp
         from math import log
```

```
In [64]: def parseData(fname):
           for l in urlopen(fname):
             yield eval(l)
```

```
In [65]: print("Reading data...")
         data = list(parseData("http://jmcauley.ucsd.edu/cse190/data/beer/beer_50000.json"))
         print("done")
```

```
Reading data...
done
```

```
In [66]: def feature(datum):
           feat = [1, datum['review/taste'], datum['review/appearance'], \
                   datum['review/aroma'], datum['review/palate'], datum['review/overall']]
           return feat
```

```
In [67]: def inner(x,y):
           return sum([x[i]*y[i] for i in range(len(x))])

         def sigmoid(x):
           return 1.0 / (1 + exp(-x))
```

```
In [68]: ##################################################
         # Logistic regression by gradient ascent         #
         ##################################################
         # NEGATIVE Log-likelihood
         def f(theta, X, y, lam):
           loglikelihood = 0
           for i in range(len(X)):
             logit = inner(X[i], theta)
```

```
      loglikelihood -= log(1 + exp(-logit))
      if not y[i]:
        loglikelihood -= logit
    for k in range(len(theta)):
      loglikelihood -= lam * theta[k]*theta[k]
    # for debugging
    # print("ll =" + str(loglikelihood))
    return -loglikelihood

  # NEGATIVE Derivative of log-likelihood
  def fprime(theta, X, y, lam):
    dl = [0]*len(theta)
    for i in range(len(X)):
      logit = inner(X[i], theta)
      for k in range(len(theta)):
        dl[k] += X[i][k] * (1 - sigmoid(logit))
        if not y[i]:
          dl[k] -= X[i][k]
    for k in range(len(theta)):
      dl[k] -= lam*2*theta[k]
    return numpy.array([-x for x in dl])
```

0.1 Problem 1

In [69]:
```
import random
random.shuffle(data)
X = [feature(d) for d in data]
y = [d['beer/ABV'] >= 6.5 for d in data]
```

In [70]:
```
X_train = X[:len(X)//3]      # top 1/3 of the shuffled data
y_train = y[:len(y)//3]
##################################################
# Train                                          #
##################################################

def train(lam):
  theta,_,_ = scipy.optimize.fmin_l_bfgs_b(f, [0]*len(X[0]), fprime, pgtol = 10, args
  return theta
```

In [71]:
```
##################################################
# Predict                                        #
##################################################

def performance(theta,X,Y):
  scores = [inner(theta,x) for x in X]
  predictions = [s > 0 for s in scores]
  correct = [(a == b) for (a,b) in zip(predictions,Y)]
  acc = sum(correct) * 1.0 / len(correct)
  return acc
```

```
In [72]: ###################################################
         # Validation pipeline                              #
         ###################################################
         ### training set
         lam = 1.0

         theta = train(lam)
         acc = performance(theta,X_train,y_train)
         print("lambda = " + str(lam) + ":\taccuracy of the training set=" + str(acc))
```

```
lambda = 1.0:       accuracy of the training set=0.7224888995559823
```

```
In [73]: ### validation set

         X_validation=X[len(X)//3:2*len(X)//3]
         y_validation=y[len(y)//3:2*len(y)//3]
         acc1 = performance(theta,X_validation,y_validation)
         print("lambda = " + str(lam) + ":\taccuracy of the validation set=" + str(acc1))
```

```
lambda = 1.0:       accuracy of the validation set=0.7171656566868663
```

```
In [74]: ### test set

         X_test=X[2*len(X)//3:]
         y_test=y[2*len(y)//3:]
         acc2 = performance(theta,X_test,y_test)
         print("lambda = " + str(lam) + ":\taccuracy of the validation set=" + str(acc2))
```

```
lambda = 1.0:       accuracy of the validation set=0.7178856422871542
```

0.2 Problem 2

```
In [75]: ### P/N/TP/TN/FP/FN of the test set
         scores2 = [inner(theta,x) for x in X_test]
         predictions2 = [s > 0 for s in scores2]

         ###  positives
         nums_positive = sum(predictions2)
         print("The number of predicted positives:\t" + str(nums_positive))

         ### negatives
         nums_negative = len(predictions2)-nums_positive
         print("The number of predicted negatives:\t" + str(nums_negative))

         ### True Positives
         TP = [(a == b and a == True) for (a,b) in zip(predictions2,y_test)]
```

```
nums_TP = sum(TP)
print("The number of True Positives:\t" + str(nums_TP))

### True Negatives
TN = [(a == b and a == False) for (a,b) in zip(predictions2,y_test)]
nums_TN = sum(TN)
print("The number of True Negatives:\t" + str(nums_TN))

### False Positives
FP = [(a == True and b == False) for (a,b) in zip(predictions2,y_test)]
nums_FP = sum(FP)
print("The number of False Positives:\t" + str(nums_FP))

### False Negatives
FN = [(a == False and b == True) for (a,b) in zip(predictions2,y_test)]
nums_FN = sum(FN)
print("The number of False Negatives:\t" + str(nums_FN))
```

```
The number of predicted positives:        12350
The number of predicted negatives:        4317
The number of True Positives:        9038
The number of True Negatives:        2927
The number of False Positives:        3312
The number of False Negatives:        1390
```

0.3 Problem 3

If we want to assign greater importance to False Positives as compared to False Negatives, we could reduce the likelihood of FP, that is, case y>0 and logit<0.

```
In [86]: ##################################################
         # Logistic regression by gradient ascent         #
         ##################################################
         # NEGATIVE Log-likelihood
         def f_weighted(theta, X, y, lam):
           loglikelihood = 0
           for i in range(len(X)):
             logit = inner(X[i], theta)
             loglikelihood -= log(1 + exp(-logit))
             if not y[i]:
                 if logit>0 :
                     loglikelihood -= logit*1.4  ## modified place
                   #  loglikelihood *= 10
                 else :
                     loglikelihood -= logit
           for k in range(len(theta)):
             loglikelihood -= lam * theta[k]*theta[k]
```

```
    # for debugging
    # print("ll =" + str(loglikelihood))
    return -loglikelihood

  # NEGATIVE Derivative of log-likelihood
  def fprime_weighted(theta, X, y, lam):
    dl = [0]*len(theta)
    for i in range(len(X)):
      logit = inner(X[i], theta)
      for k in range(len(theta)):
        dl[k] += X[i][k] * (1 - sigmoid(logit))
        if not y[i]:
          if logit >0 :
             dl[k] -= X[i][k]*1.4
           #  dl[k] *= 10
          else :
             dl[k] -= X[i][k]
    for k in range(len(theta)):
      dl[k] -= lam*2*theta[k]
    return numpy.array([-x for x in dl])

  def train_weighted(lam):
    theta,_,_ = scipy.optimize.fmin_l_bfgs_b(f_weighted, [0]*len(X[0]), fprime_weighted
                                             args = (X_train, y_train, lam))
    return theta
```

```
In [87]: theta1 = train_weighted(lam)
         scores_weighted = [inner(theta1,x) for x in X_test]
         predictions_weighted = [s > 0 for s in scores_weighted]

         ### True Positives
         TP1 = [(a == b and a == True) for (a,b) in zip(predictions_weighted,y_test)]
         nums_TP1 = sum(TP1)
         print("The number of True Positives:\t" + str(nums_TP1))

         ### True Negatives
         TN1 = [(a == b and a == False) for (a,b) in zip(predictions_weighted,y_test)]
         nums_TN1 = sum(TN1)
         print("The number of True Negatives:\t" + str(nums_TN1))

         ### False Positives
         FP1 = [(a == True and b == False) for (a,b) in zip(predictions_weighted,y_test)]
         nums_FP1 = sum(FP1)
         print("The number of False Positives:\t" + str(nums_FP1))

         ### False Negatives
         FN1 = [(a == False and b == True) for (a,b) in zip(predictions_weighted,y_test)]
         nums_FN1 = sum(FN1)
```

```
print("The number of False Negatives:\t" + str(nums_FN1))
```

```
The number of True Positives:        8418
The number of True Negatives:        3634
The number of False Positives:        2605
The number of False Negatives:        2010
```

0.4 Problem 4

```
In [88]: #### lam = 0
         theta_0 = train(0)
         acc_0 = performance(theta_0,X_validation,y_validation)
         print("lambda = " + str(0) + ":\taccuracy of the validation set=" + str(acc_0))

         ### lam = 0.01
         theta_1 = train(0.01)
         acc_1 = performance(theta_1,X_validation,y_validation)
         print("lambda = " + str(0.01) + ":\taccuracy of the validation set=" + str(acc_1))

         ### lam = 0.1
         theta_2 = train(0.1)
         acc_2 = performance(theta_2,X_validation,y_validation)
         print("lambda = " + str(0.1) + ":\taccuracy of the validation set=" + str(acc_2))

         ### lam = 1
         theta_3 = train(1)
         acc_3 = performance(theta_3,X_validation,y_validation)
         print("lambda = " + str(1) + ":\taccuracy of the validation set=" + str(acc_3))

         ### lam = 100
         theta_4 = train(100)
         acc_4 = performance(theta_4,X_validation,y_validation)
         print("lambda = " + str(100) + ":\taccuracy of the validation set=" + str(acc_4))
```

```
lambda = 0:        accuracy of the validation set=0.7177056458870823
lambda = 0.01:        accuracy of the validation set=0.7177056458870823
lambda = 0.1:        accuracy of the validation set=0.7177656446871062
lambda = 1:        accuracy of the validation set=0.7171656566868663
lambda = 100:        accuracy of the validation set=0.6693466130677387
```

The best λ is 100

```
In [89]: acc_train = performance(theta_4,X_train,y_train)
         print("lambda = " + str(100) + ":\taccuracy of the train set=" + str(acc_train))
         acc_test = performance(theta_4,X_test,y_train)
         print("lambda = " + str(100) + ":\taccuracy of the test set=" + str(acc_test))
```

```
lambda = 100:        accuracy of the train set=0.6740669626785072
lambda = 100:        accuracy of the test set=0.5965438617544702
```

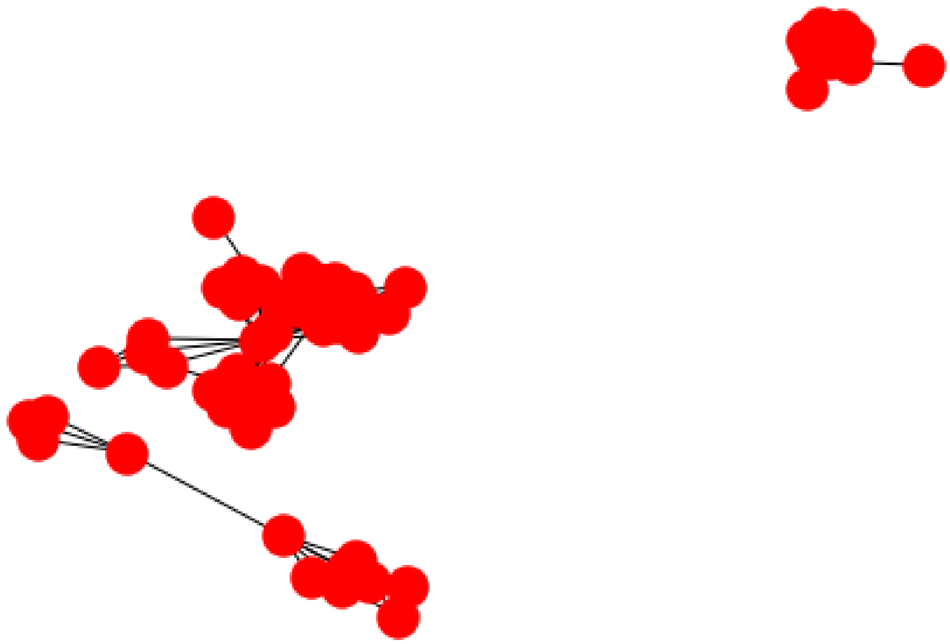
1 Task 2

1.1 problem 5

```
In [40]: ### Network visualization ###
         import networkx as nx
         import matplotlib.pyplot as plt

In [41]: edges = set()
         nodes = set()
         for edge in urlopen("http://jmcauley.ucsd.edu/cse258/data/facebook/egonet.txt"):
           x,y = edge.split()
           x,y = int(x),int(y)
           edges.add((x,y))
           edges.add((y,x))
           nodes.add(x)
           nodes.add(y)

In [42]: G = nx.Graph()
         for e in edges:
           G.add_edge(e[0],e[1])
         nx.draw(G)
         plt.show()
         plt.clf()
```



```
<Figure size 432x288 with 0 Axes>
```

```
In [43]: ### define a dict :group  [ key: node i; value: all node j if (i,j) in edges]
         group={}
         for edge in edges :
             if edge[0] in group :
                 group[edge[0]].add(edge[1])
             else :
                 group[edge[0]]=set([edge[1]])


         ### use BFS to find all nodes that belongs to one group
         def get_all_connected_groups(graph):
             already_seen = set()
             result = []
             for node in graph:
                 if node not in already_seen:
                     connected_group, already_seen = \
                     get_connected_group(graph,node, already_seen)
                     result.append(connected_group)
             return result
```

```
def get_connected_group(graph,node, already_seen):
        result = []
        nodes = set([node])
        while nodes:
            node = nodes.pop()
            already_seen.add(node)
            nodes.update(graph[node] - already_seen)
            result.append(node)
        return result, already_seen

components = get_all_connected_groups(group)
#print(components)

print("\n The number of connected components:\t" +str(len(components)))
length = [0]*len(components)
for i in range(len(components)):
    length[i] = len(components[i])
print("The largest component's node number\t"+str(max(length)))
```

```
 The number of connected components:        3
The largest component's node number        40
```

1.2 Problem 6

```
In [44]: ### new_graph is the largest connected component
         new_graph = components[0]
         new_graph.sort()

         ### split new_graph into two parts
         graph1 = new_graph[:len(new_graph)//2]
         graph2 = new_graph[len(new_graph)//2:]

         ### find the normalized cut
         def norm_cut(graph1,graph2) :
             cut = 0
             degree1 = sum(G.degree(node1) for node1 in graph1)
             degree2 = sum(G.degree(node2) for node2 in graph2)
             for node1 in graph1 :
                for node2 in graph2 :
                   if (node1,node2) in edges:
                       cut+=1
             Norm_cut=0.5 * (cut/degree1 + cut/degree2)
             return Norm_cut
         res = norm_cut(graph1,graph2)
         print("The normalized cut cost is: "+ str(res))
```

```
The normalized cut cost is: 0.42240587695133147
```

1.3 Problem 7

In [50]:
```python
# minimize the cost, if new generated cost is higher than the
# previous one, then stop

old_min_cost = res
new_min_cost = res
while True :
    if old_min_cost < new_min_cost :
        break
    else :
        old_min_cost = new_min_cost

    cost = [0] * len(new_graph)
    for i in range(len(new_graph)) :
      g1= graph1.copy()
      g2= graph2.copy()
      if new_graph[i] in g1 :
          g2 += [new_graph[i]]
          del g1[g1.index(new_graph[i])]
      else :
          g1 += [new_graph[i]]
          del g2[g2.index(new_graph[i])]
      cost[i] = norm_cut (g1, g2)

    move_point = cost.index(min(cost))

    if new_graph[move_point] in graph1 :
       graph2 += [new_graph[move_point]]
       del graph1[graph1.index(new_graph[move_point])]
    else :
       graph1 += [new_graph[move_point]]
       del graph2[graph2.index(new_graph[move_point])]
    new_min_cost =  min(cost)

print("The normalized cut cost is "+str(old_min_cost))
print("nodes in Community 1: "+str(graph1))
print("nodes in Community 2: "+str(graph2))

### because the content is cut when saving as PDF,
### I will show the result in annotation
### community 1:[697, 703, 708, 713, 719, 745, 747, 753, 769, 772, 774,
### 800, 803, 805, 810, 811, 819, 828, 823, 830, 840, 880, 890, 869, 856]
### community 2: [825, 861, 863, 864, 876, 878, 882, 884,
### 886, 888, 889, 893, 729, 804, 798]
```

```
The normalized cut cost is 0.09817045961624274
nodes in Community 1: [697, 703, 708, 713, 719, 745, 747, 753, 769, 772, 774, 800, 803, 805, 8
nodes in Community 2: [825, 861, 863, 864, 876, 878, 882, 884, 886, 888, 889, 893, 729, 804, 7
```

1.4 Problem 8

In [55]:
```python
## new_graph : 40 nodes : a connected tcommunity
## all_edge : number of edges in the new_graph
all_edge = sum([G.degree(v) for v in new_graph])/2
#print(all_edge)

## split into two parts
graph_1 = new_graph[:len(new_graph)//2]
graph_2 = new_graph[len(new_graph)//2:]

### compute Q
def q(all_edge, g1, g2):
    count =0
    for i in g1 :
        for j in g2 :
            if (i,j) in edges :
              count += 1
    q_=(all_edge-count)/all_edge
    a = sum([G.degree(v) for v in g1])
    q_ -= (a/(all_edge*2))**2
    a = sum([G.degree(v) for v in g2])
    q_ -= (a/(all_edge*2))**2
    return q_

### Greedy algorithm , when new Q is not increasing, stop.
old_q = new_q = -0.5
while True :
    if old_q > new_q :
        break
    else :
        old_q = new_q

    q_list = [0] * len(new_graph)
    for i in range(len(new_graph)) :
       g1 = graph_1.copy()
       g2 = graph_2.copy()
       if new_graph[i] in g1 :
          g2 += [new_graph[i]]
          del g1[g1.index(new_graph[i])]
       else :
          g1 += [new_graph[i]]
          del g2[g2.index(new_graph[i])]
```

```
            q_list[i] = q(all_edge, g1, g2)

        mp= q_list.index(max(q_list))
        if new_graph[mp] in graph_1 :
            graph_2 += [new_graph[mp]]
            del graph_1[graph_1.index(new_graph[mp])]
        else :
            graph_1 += [new_graph[mp]]
            del graph_2[graph_2.index(new_graph[mp])]
        new_q = max(q_list)
    print("Community 1:"+str(graph1))
    print("Community 2:"+str(graph2))
    print("modularity values for the split: "+str(old_q))

    ### the two community we found here is the same with that in Problem 7
```

```
Community 1:[697, 703, 708, 713, 719, 745, 747, 753, 769, 772, 774, 800, 803, 805, 810, 811, 8
Community 2:[825, 861, 863, 864, 876, 878, 882, 884, 886, 888, 889, 893, 729, 804, 798]
modularity values for the split: 0.3380165289256196
```

In [ ]: